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THE PHYSIOGRAPHIC ECOLOGY OF CHICAGO AND VICINITY; A STUDY OF THE ORIGIN, DEVELOPMENT, AND CLASSIFICATION OF PLANT SOCIETIES.

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY XXIV.

HENRY CHANDLER COWLES.

[*Concluded from p. 108.*]

2. THE POND-SWAMP-PRAIRIE SERIES.

A. *The pond.*—There are all gradations between rapid streams and completely undrained ponds, and corresponding with these various gradations are characteristic plant species. It will be convenient to subdivide the series under discussion into two parts, the first dealing with undrained ponds and swamps, the second with half-drained ponds and swamps.

No two floras can be more unlike in species or in adaptations than are the typical brookside and swamp floras. Though each type may be called hydrophytic, so far as the water is concerned, the vegetation is really hydrophilous in the first case but pronouncedly xerophilous in the second. Peat bogs which may be taken as the type of undrained swamps have a remarkable assemblage of xerophytic adaptations, such as leathery or hairy leaves, and special structures for water absorption. Schimper[23] believes

[23] SCHIMPER: Pflanzengeographie, p. 18.

that these structures are due to the difficult absorption in peaty soil, the humus acids and the lack of oxygen being detrimental to normal root activities. For similar reasons the normal soil activities of bacteria and fungi are lessened, and as a result of this relative lack of decay great quantities of peat accumulate. All of these peculiarities of peat bogs may be referred to the lack of drainage, since the stagnant conditions prevent oxidation and the removal of the humus acids. The lack of drainage is of course due to topographic conditions. Peat bogs and undrained lakes, therefore, are features of a young topography, since several agencies combine to cause their rapid destruction. Rivers may work back and tap the undrained lakes or inlets may fill them up. Probably the most important agent in the death of undrained lakes, however, is the vegetation, as will be seen later. The great abundance of lakes and ponds in the young glaciated regions as compared with older regions to the south is a striking proof of their short life.

In the immediate neighborhood of Chicago typical peat bogs are scarce. They find their best development in the depressions of the dune region, where they may be called abundant. Wherever a sag between two dunes is low enough to retain moisture for the greater part of the season, the conditions favor the development of an undrained swamp flora. If the depression is so low that the water level outcrops throughout the year, then there is an undrained pond or lake. The first flora in this latter case consists of plants that are able to exist with little or no change in the water of the pond except through rain and evaporation. Among these plants the alga Chara takes a prominent place. The water lilies (Nymphaea and Nuphar) are an exceedingly important constituent of this first vegetation, as is also Utricularia, which is represented by several species. The above species, together with others, play a great part in filling up lakes, since their remains accumulate with almost no decay. Chara in particular is a soil former of great importance. The rapidity with which these filling processes are carried on is striking; in pools of known age among the rubbish heaps of

Jackson park the author has noticed accumulations of Chara peat amounting to one or two inches per year.

B. *The undrained swamp.*— It is obvious that the processes outlined in the preceding paragraph must eventuate in the death of the lake or pond involved and its replacement by a marsh, entirely apart from ordinary erosive activities. Indeed, as has been stated, these activities are relatively unimportant here; this fact is shown by the absence of ordinary sediments from most peat beds. As the aquatics make the pond shallower and shallower they make it more and more unfit for themselves and fit for their successors, viz., those plants which grow along pond margins. Among the first plants of this type are various sedges (Carex), also the bulrush (*Scirpus lacustris*), though this latter species is more characteristic of the half-drained margins than of those under discussion here. Other marginal plants of our peat bogs are *Menyanthes trifoliata* and *Potentilla palustris*.

The vegetation that follows may be called typical of peat bogs. The dominant plants are usually shrubs, especially the leather leaf (*Cassandra calyculata*); this plant may be so abundant as to give tone to the landscape. *Fig. 19* shows some Cassandra islands in a sedge swamp. It is clear that the islands represent places where in the original lake the water was shallow. The present remnant of the lake is shown at the left. Not only have the sedge zones advanced upon it from all sides, but centers of sedge growth appear also in shallow places in the lake itself. Just as the sedge zone encroaches upon the lake, when conditions become favorable, so the Cassandra zone advances on the sedges. Again a tree zone advances on the shrubs, as will be seen farther on. The zonal arrangement of plant societies that has just been seen is a feature of most peat bogs, and is due to the symmetry of lake and bog conditions. It will be observed that along the lake margin the zones advance toward a common center, while on the islands the advance is from a center. Eventually, of course, the marginal and island zones will merge.

Besides Cassandra many other plants are commonly found

in the shrub zone. Other shrubs are the swamp blueberry (*Vaccinium corymbosum*), the cranberry (*Vaccinium macrocarpon*), the dwarf birch (*Betula pumila*), the alder (*Alnus incana*), the hoary willow (*Salix candida*), and the poison sumach (*Rhus venenata*). Characteristic herbs, especially in the open places, are the pitcher plant (*Sarracenia purpurea*), the sundew (*Drosera rotundifolia*),

FIG. 19.—Typical peat bog in a depression between established dunes at Miller. Relict of the original pond at the left. Sedges (light-colored vegetation) are encroaching on the lake, while shrubs, mainly Cassandra, are encroaching on the sedges. Cassandra islands toward the right. Advance of conifers on Cassandra (seen in its beginnings on the islands) shown at the extreme right.

various orchids, as *Calopogon pulchellus*, Pogonia, and Cypripedium; sedges, as Eriophorum and Dulichium; *Woodwardia Virginica*, and *Elodes campanulata*. One of the most typical plants of these places is the peat moss, Sphagnum.

The flora just mentioned has many interesting features which are well known and may be passed over briefly. The highly xerophytic character of this plant society has already been noticed, and the reasons for it briefly given. The xerophytic structures are well illustrated in the leathery leaves of Cassandra and the absorption and storage adaptations of Sphagnum.

Many bogs of this type are very spongy and unstable, whence the name quaking bogs; this feature is due to the rapid growth of the vegetation and the absence of ordinary inorganic soils for a considerable depth. The similarity of the peat bog vegetation throughout the northern hemisphere is one of its most striking features. Not only the adaptations but the species themselves

FIG. 20.—Tamarack swamp in an undrained portion of the Calumet flood plain at Miller. Peat bog herbs and shrubs in the foreground.

are similar over vast areas; the conditions are unique and the flora also. None of our plant societies, not even the lakeward dune slopes, have such a pronounced northern flora as do the peat bogs. No contrast could be more striking than that between the southern vegetation of the flood plains and the northern flora of the bogs.

Fig. 19 shows that a coniferous vegetation, now represented by but two or three small trees at the centers of the islands, is to follow the Cassandra. Such an advance of conifers on Cassandra is shown in the background at the right. The most typical conifer in such cases is the tamarack (*Larix Americana*); with this the arbor vitae (*Thuya occidentalis*) is sometimes found.

Larix and Thuya swamps reach but an imperfect development in our region and little need be said about them. The shade in these forest swamps is so dense that bare patches of soil are often seen. The vegetation consists largely of shade plants, among which may be mentioned Mnium and other similar mosses, *Coptis trifolia*, *Cornus Canadensis*, *Viola blanda*, and Impatiens. The tamaracks appear to be succeeded by the pines (*Pinus Strobus* or *P. Banksiana*), and they in turn by oaks, as the soil becomes drier and better drained, and thus more adapted to deciduous trees. *Fig. 20* shows a tamarack swamp near Miller, Ind.

Not all peat bogs have a history like the above. Just as some flood plains are forested and others not, so some peat bogs grow up to shrubs and trees, while others are dominated, for a long time at least, by herbs and grasses. *Fig. 21* shows a swamp of this character. Bulrushes are seen to be encroaching upon the water lily vegetation, while back of the bulrushes, instead of Cassandra, is a zone with sedges and grasses and scattered willows. Among the species, other than sedges and grasses in a plant society like this are *Viola sagittata* and *V. lanceolata*, *Potentilla Anserina*, *Fragaria Virginiana*, *Parnassia Caroliniana*, *Sabbatia angularis*, *Gentiana crinita*, *Gerardia purpurea*, *Castilleia coccinea*, *Aletris farinosa*, *Iris versicolor*, *Sisyrinchium angustifolium*, *Hypoxys erecta*, *Xyris flexuosa*, *Triglochin maritima*. The shrubs in such places are chiefly *Salix glaucophylla*, *Cornus stolonifera*, *Potentilla fruticosa*, *Hypericum Kalmianum*. The conditions that determine this type of bog, as contrasted with the Cassandra type, are not clear. The soil is hard, compact, shallow, and usually sandy; it may be that this type develops in shallow depressions, while the type with spongy, quaking ground develops in deeper depressions. This second type much more closely resembles the half-drained swamps in its flora than does the Cassandra type, although so far as drainage is concerned it agrees with the Cassandra bogs.

There is yet a third type of swamp which still more closely resembles the half-drained swamp in its flora. It is found along the edge of the Calumet valley near Dune park, also at West

Pullman. In this case the soil is rather deep and rich, in which respects there is agreement with the first type rather than the second. Grasses and sedges, but of a more luxuriant type, dominate here also, and with them are found such plants as *Cephalanthus occidentalis*, *Aspidium Thelypteris*, *Onoclea sensibilis*, *Saxifraga Pennsylvanica*, *Caltha palustris*, *Viola blanda*, *Polygala sanguinea*.

FIG. 21.—Shallow, undrained swamp (peat bog) at Dune park. In the foreground the relict of the original pond, with water lilies; then in order, encroaching zones of bulrushes, sedges, willows, and pines. The oaks in the background are on an established dune, and are not encroaching on the swampy soil.

Sphagnum occasionally occurs here, as it never does in the second type. Here again there is doubt as to the determining conditions, but it may be that things can be explained by the difference in the drainage. The ultimate fate of the second and third swamp types is not known. The relative absence of trees and shrubs is certainly natural and in no wise due to man.

Possibly local prairies will be the final type, or it may be that the forest will come in. *Fig. 21*, which shows pines encroaching upon the grassy areas, favors the latter view. So do some of the facts seen in the Calumet valley.

All of the peat bog types have a characteristic marginal flora, *i. e.*, the vegetation at the margin of the original lake is essentially alike in all cases. These plants, as well as those of

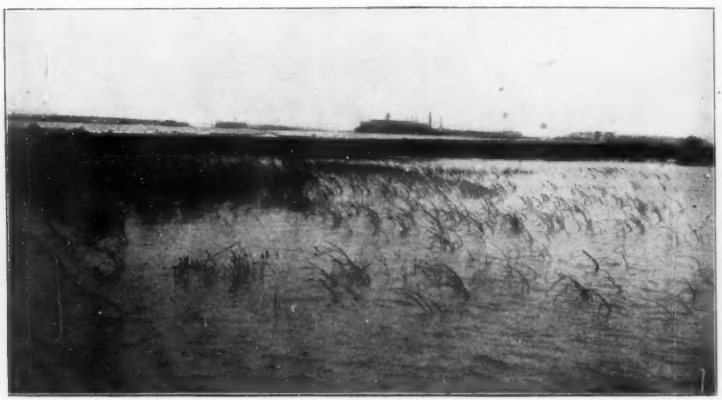

FIG. 22.—Encroachment of bulrushes on Calumet lake, showing how plants may destroy lakes.

Cassandra bogs, are the same over wide areas. The most common members of the bog margin flora are the sour gum (*Nyssa sylvatica*), the aspen (*Populus tremuloides*), *Ilex verticillata*, *Pyrus arbutifolia* (including var. *melanocarpa*), *Spiraea salicifolia* and *S. tomentosa*, *Rubus hispidus*, *Gaultheria procumbens*, *Osmunda cinnamomea*, *O. Claytoniana*, *O. regalis*, *Betula papyrifera*, and *Polytrichum commune*. This vegetation originates outside the swamp, and may be regarded as xerophytic; however, it often encroaches upon the swamp as the latter develops. At Thornton there is a dead swamp which is now almost entirely occupied by this xerophytic bog margin flora, only a few of the original swamp plants now remaining. Near Morgan park is a

bog margin flora without a bog; a shallow trench has been dug and in this trench there have appeared various peat bog plants, *e. g.*, Sphagnum. These considerations show that bog margin floras, though associated with most bogs, are not necessarily genetically connected with them.

A word may be said about undrained swamps among the active dunes. The conditions here, of course, are far more severe than in ordinary peat bogs and only a few species are

FIG. 23.—Pond at Waukegan almost destroyed by bulrushes.

able to endure in such a habitat. The most typical herb is *Juncus Balticus littoralis*. Seedlings of the cottonwood, as well as the long-leaved and glaucous willows, germinate in these wet depressions. Reference will be made to these plants in connection with the dunes.

In the morainic portions of our territory there are few if any peat bogs as described above, although they are usually more typical of moraines than of other topographic areas. On account of the clay soil which characterizes the morainic uplands there are many patches of swampy woods throughout the district. Shallow depressions of this type in sandy soil would not have a swamp developed. Morainic forest swamps are characterized by several trees, viz.: the bur oak, swamp white oak, and scarlet

oak (*Quercus macrocarpa*, *Q. bicolor*, and *Q. coccinea*), the red maple (*Acer rubrum*), the elm (*Ulmus Americana*), and the ash (*Fraxinus Americana*). Other species are *Cephalanthus occidentalis*, *Salix discolor*, *Ribes floridum*, *Cardamine rhomboidea purpurea*, *Ranunculus septentrionalis*. This vegetation is ultimately supplanted by the mesophytic forest. A vegetation allied with that

FIG. 24.—Typical grass prairie near Pullman. This prairie has been reclaimed naturally from Lake Calumet, and has passed through bulrush and sedge stages.

of swamps is the amphibious ditch flora with such plants as *Nasturtium palustre*, *Penthorum sedoides*, *Proserpinaca palustris*, *Ludwigia palustris*, *Polygonum Hydropiper*, etc.

Calumet lake and Grand Calumet river may be taken as types of half-drained waters. We have here conditions that are midway between those of peat bogs and those of ordinary rivers. The vegetation is subject neither to the currents of the rivers nor to the stagnant conditions of the peaty lakes, and hence the luxuriance of the flora is far greater than in either of the other instances. The aquatic vegetation is rich both in species and

individuals. Here is to be found a great wealth of alga vegetation, including such forms as Cladophora, Spirogyra, Oedogonium, Hydrodictyon. Among the floating plants are Riccia, Ricciocarpus, Spirodela, Lemna, and Wolffia. There are also a large number of attached plants, including many species of Potamogeton, *Ranunculus aquatilis*, Brasenia, Nelumbo, Myriophyllum, Ceratophyllum, Elodea, Vallisneria, and Naias. This rank growth of vegetation fills the lake up rapidly, since the currents are not sufficient to carry off the plant remains. There is a rapid advance of marginal plants upon the lake, a phenomenon that is shown in *fig. 22*, where the scattered bulrushes (*Scirpus lacustris*) are seen to be soon followed by a dense bulrush society. With or soon after the bulrushes are a number of marginal plants, especially *Typha latifolia*, *Pontederia cordata*, *Sparganium eurycarpum*, *Sagittaria variabilis* and *S. heterophylla*, *Zizania aquatica*, *Phragmites communis*, *Acorus Calamus*, and *Eriophorum cyperinum*. *Fig. 23* shows a stage in which a lake has been all but destroyed by a rank bulrush vegetation.

C. *The prairie.*—Sedges encroach rapidly upon the bulrushes as the new soil becomes raised more and more above the lake, and grasses in turn encroach upon the sedges, forming a prairie. *Fig. 24* shows an expanse of grassy prairie which has developed through these successive stages from Calumet lake. Skokie marsh and Hog marsh are undergoing transformations of this character also. Sometimes with the prairie grasses are a number of coarse xerophytic herbs, largely composites (*Silphium laciniatum*, *S. terebinthinaceum*, *S. integrifolium*, Lepachys, *Solidago rigida*, Aster, Liatris), with some legumes (*Amorpha canescens*, Petalostemon, Melilotus, Baptisia), Eryngium, Dodecatheon, Phlox, *Allium cernuum*. A Silphium (compass plant) prairie is shown in *fig. 25*. The prairies of our area are in the basin of the glacial Lake Chicago, and hence all may be referred to a lake or swamp origin, exactly as prairies are developing from Calumet lake today. This explanation of the prairie, an undoubted explanation for the cases in hand, must not be applied to the great climatic prairies farther west. Whether

the Chicago prairies will ever become forested is a question not easily answered. There are signs of it in some places, as at Stony island, but this topic needs more detailed treatment than can be given here.

The processes outlined in this section are rapid. The mesophytic prairie or forest develops from the lake or marsh, while the region as a whole still retains a young topography. Thus

FIG. 25.—Prairie at Pullman in which the compass plant (Silphium) grows with the grasses. This prairie is much older and drier than that shown in *fig. 24*.

this mesophytic assemblage, like that of the ravine slope, is bound to pass away, though its life tenure is much longer. Sooner or later river action will enter; there will be developed ravines, xerophytic bluffs, and ultimately flood plains, again with a mesophytic flora. A broad survey then shows a rapid development to a somewhat prolonged temporary climax, and finally after ravine and bluff vicissitudes there appears the true and more enduring climax of the mesophytic flood plain.

3. THE UPLAND SERIES.

A. *The rock hill.*—While all of a land area is eventually worked over by stream activities and can thus be referred to the

river series, other activities are at work in a young topography. The swamp series which has just been discussed is one illustration. So also there are hills which are not due to erosive processes, but to other causes, notably in our region morainic

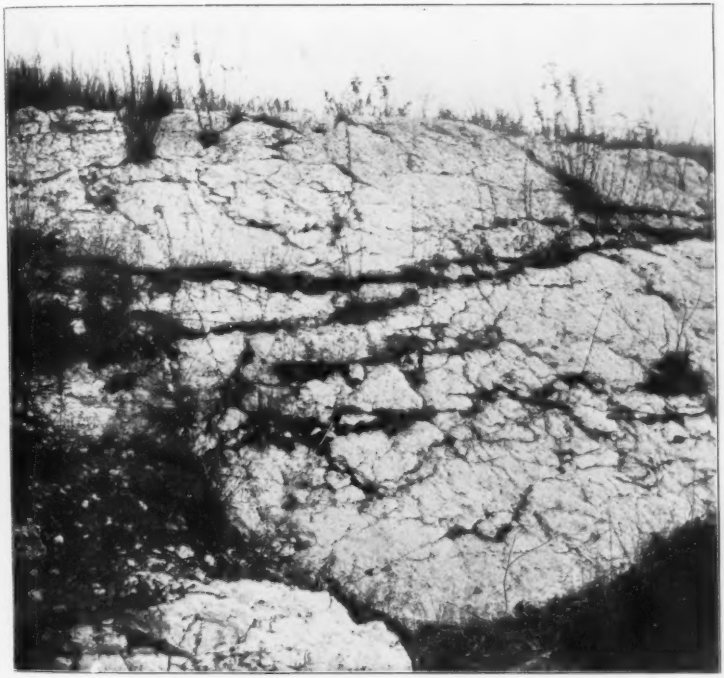

FIG. 26.—Slope of limestone ledge at Stony island, showing mosses and higher plants establishing themselves in the crevices.

hills and sand hills. There are rock hills also which are not connected with the present erosion cycle. All of these hill types have their peculiar vegetation features and must be discussed apart from river activities, since they have an interesting history before they are attacked by stream erosion.

We may speak first of rock hills, which in the vicinity of

Chicago are quite rare and consist entirely of dolomitic Niagara (Silurian) limestone. Not only are hills of this limestone quite rare, but surface outcrops of any kind are uncommon because of the heavy drift. Hence the rock vegetation of the Chicago area is not very important. Perhaps the most interesting outcrop is at Stony island, where it is quite easy to trace the various stages in the development of the vegetation. This rock, like most limestone, is subject to chemical as well as mechanical erosion, but is much more resistant than most limestones on account of its strongly dolomitic character. The first vegetation that gets a foothold is composed of lichens, but the lichen flora appears to be rather sparse, perhaps because of the chemical nature of the rock, since lichens are commonly supposed to shun calcareous soils. The relative poverty of lichens may be due, however, to the easy solution of the surface rock layers and the consequent difficulty in retaining a foothold. The limestone is considerably jointed and fractured and there is in consequence a rich crevice vegetation, composed of several mosses, especially Ceratodon and Bryum, and also various grasses. *Fig. 26* shows a vegetation of this nature, and among the other crevice plants is an abundance of *Solidago nemoralis*. Other species growing in the crevices or on the first soil which is formed on the rock face are *Potentilla arguta*, *Verbascum Thapsus*, *Heuchera hispida*, *Poa compressa*, etc. At Thornton there is a rock outcrop which gradually recedes from the surface, and it is possible to tell by the vegetation where the rock surface dips considerably under the surface of the soil. Where the soil is shallow the dominant plant is *Poa compressa*, but as the soil layer deepens it becomes gradually replaced by *Poa pratensis*. Similarly at Stony island crevices can be distinguished in a covered horizontal rock surface by a sudden change from the xerophytic plants of the shallow soil, that hides most of the rock, to the mesophytic plants of the deeper soil which lies over the crevices.

Through rock decay and the accumulation of organic matter a considerable soil comes to be developed where there was at

first an outcrop of bare rock. The opportunity for a shrubby vegetation eventually arrives, especially in the crevices. *Fig. 27* shows such a vegetation getting a foothold. Among the shrubs in such places are the chokecherry (*Prunus Virginiana*),

FIG. 27.—Limestone ledge at Stony island, showing vegetation farther advanced than in *fig. 26*. The crevice shrubs here are chokecherries (*Prunus Virginiana*).

ninebark (*Physocarpus opulifolius*), poison ivy (*Rhus Toxicodendron*), *Rosa humilis*, sumach (*Rhus typhina*), hop tree (*Ptelea trifoliata*), wild crab (*Pyrus coronaria*). Still later the way is open for a tree vegetation, at first xerophytic, but ultimately mesophytic, as the author has frequently observed in the Alleghanies. There can be no doubt but that a temporary mesophytic climax can be reached even on rock hills, though the probability of this

is much greater where the hill is composed of limestone than in the case of sandstone or granite.

B. *The clay hill.*— Morainic hills are common in the Chicago region and almost without exception they are covered with a mesophytic forest, in which the dominant trees are usually the

FIG. 28.—Typical upland clay (morainic) forest at Beverly hills. The dominant trees here are red oaks (*Quercus rubra*), though a white oak (*Q. alba*) is shown at the extreme right.

white oak (*Quercus alba*), the red oak (*Quercus rubra*), and the shell-bark hickory (*Carya alba*). This is easily the dominant forest type of the Chicago region, and is remarkably characteristic of morainic areas. The soil in all cases is a glacial clay or till, heterogeneous in composition, but rich in food salts. Of all our plant society life histories these are about the most difficult to unravel and it is due to the favorable conditions under which they have developed. After the continental glacier left this region for the last time, it was doubtless on these low

morainic hills that the first mesophytic forests were developed. And they have been developed for so long that almost no traces of their history are left behind; we have only the completed product, the mesophytic forest.

Where these mesophytic forests are disturbed we may perhaps get some notion of what took place in the first postglacial centuries. On the clay banks along the drainage canal and also on recent river bluffs, one may follow in rapid succession a series of plant societies leading to the forest. There is here no pronounced lichen or moss stage as on rock hills, but the first vegetation consists of xerophytic annuals and perennial herbs. Xerophytic shrubs, especially Salix and Populus, soon appear. It is not long before there is an extensive thicket formation with an herbaceous undergrowth. Humus accumulates with great rapidity and we soon have almost a mesophytic vegetation in which the dominant thicket species are likely to be the aspen (*Populus tremuloides*), wild crab (*Pyrus coronaria*), red haw (*Crataegus punctata*, *C. coccinea*, etc.). Such a thicket is the immediate forerunner of the oak-hickory type of mesophytic forest. When a forest of oak and hickory is cut down or destroyed by fire it returns after a comparatively short interval, but the first stages in the clearing are thicket stages much like those just described. Of course it takes much longer to develop a forest from naked clay soil than from a forest land that has been cleared. Whether the stages that led up to the first postglacial forests are such as have been described is very doubtful. It is much more likely that the first forests were of slow growth and were coniferous in character, such as are found farther north. *Fig. 28* shows a typical morainic hill forest of the above type. Here the dominant tree is the red oak; a white oak is seen at the right.

Among the shrubs of these morainic forests there may be mentioned, apart from the crabs and haws, the hazel (*Corylus Americana*), and various species of Viburnum. Many herbaceous plants are found, among which are Podophyllum, Claytonia, various species of Aster, Trillium, *Geranium maculatum*, *Viola*

pubescens, *Anemone nemorosa*, etc. Sometimes the bur oak (*Quercus macrocarpa*) is the dominant tree in these morainic forests, though in such cases the habitat is usually more moist or else the drainage is less perfect. A bur oak forest is shown in *Fig. 29*. The transition from this type to the morainic swamp forests, already mentioned, is an easy one, and bur oaks are often

FIG. 29.—Typical forest of low morainic clay soil, made up chiefly of bur oak (*Quercus macrocarpa*).

found with the swamp white oak and other species characteristic of such places.

In spite of the abundance of the type of morainic forest described above, it is scarcely probable that it is anything more than a very slowly passing forest stage. The fact that in all directions from Chicago the ultimate forest type on morainic uplands is not the oak-hickory but the maple-beech forest leads us to expect that here. This latter type seems to be of a higher order in all respects. It is found in richer soil where the humus content is very great. Seedlings of the beech or maple can easily grow in the relatively light oak forest, whereas oaks cannot grow in the denser shade of the maple or beech. Furthermore,

oak forests have been seen with a pronounced undergrowth of beech. It would seem that one of the chief factors in determining the order of succession of forests is the light need of the various tree species, the members of the culminating forest type being those whose seedlings can grow in the densest forest shade. There are evidences that the oak forests about Chicago are being succeeded by the beech or maple. The best instance of this which the author has seen is on the low moraines along the Desplaines river west of Deerfield. The sugar maple (*Acer saccharinum*) has already been mentioned as a character plant of the temporary mesophytic forests of ravines. Here we see it in the more permanent forest of the morainic hills. The beech (*Fagus ferruginea*) is much rarer than the sugar maple, though it is a rather important constituent of the mesophytic forests about Chesterton. Why the beech-maple forest has lagged so far behind in the region about Chicago is a question not yet settled. If these forests elsewhere have had an oak stage it indicates that the development here is very slow.

Though the forests just described, whether of the oak-hickory or the maple-beech type, are of a high degree of permanence, it can be seen that this permanence is but relative. Sooner or later stream action will enter these districts and base leveling processes will begin on a more rapid scale. But for these activities the lowering of hills would be very slow indeed, so slow as hardly to interfere at any point with a luxuriant development of the vegetation. The destruction of these morainic forests by stream erosion is well shown near the shore north of Evanston and also along Thorn creek. *Fig. 18* shows a morainic island in a flood plain, the sole remnant of an extensive stretch of upland mesophytic forest. We must therefore regard upland forests as temporary also, though they endure for a much longer time than do the tempofary mesophytic forests of the ravines.

C. *The sand hill.*—A third type of upland is found in the sand hills, but since most of these in our district are of dune origin, their treatment will be deferred until later.

B. The coastal group.

I. THE LAKE BLUFF SERIES.

The plant societies that have been discussed hitherto may be found in many if not in most inland districts. The societies that follow, on the other hand, are best worked out only in connection with the coasts of oceans or great lakes. Theoretically a bluff may be composed of any kind of rock or soil, but those of our area are composed of morainic clays, and the life histories that follow will not hold good in other conditions. It may be noted here that there is a short stretch of rocky shore with lithophytic algae at Cheltenham, but there is nothing that in any way approaches a rock cliff.

Wherever a sea or lake erodes rather than deposits, there is commonly developed a sea cliff of greater or less dimensions. The material which is thus gathered may be deposited elsewhere in the form of beaches and later the wind may take up the sands from the beach and form dunes. The Chicago area gives splendid examples of these two types of sea activity; to the north of the city is an eroding coast line with its bluffs, and to the south and southeast is a depositing coast with extensive areas of beach and dune.

The lake bluffs at Glencoe give an excellent opportunity for the study of the life history of a sea-cliff vegetation. There can be almost no other habitat in our climate which imposes such severe conditions upon vegetation as an eroding clay bluff. The only possible rival in this regard is a shifting dune, and even here the dune possesses some points of advantage so far as the establishment of vegetation is concerned. In the first place, the conditions as to exposure are almost identical with those of a dune: the heat of midday and of summer and the cold of night and winter are extremely pronounced; the intensity of the light and the exposure to wind make the conditions still more severe. In other words the only plants that can grow on these lake bluffs, at least in the earlier stages, are pronounced xerophytes. Again the character of the soil is unfavorable, for while the clay is wet in the autumn, winter, and spring, it dries out in the summer and

becomes almost as hard as rock. In the heart of summer the conditions for vegetation are no better on the hard dry slopes of a clay bluff than on the hot, dry sands of a dune. Finally as to instability: it is doubtless the constant shifting of the sand which in the last analysis accounts for most of the poverty of the dune vegetation. It is similar on clay bluffs, for when the

FIG. 30.—Sea cliff along the eroding shore at Glencoe, exposing the morainic clay. Vegetation almost entirely absent. Projecting turf mats at the top show the tenacity with which the vegetation holds its ground in the face of the erosive forces

waves undermine the cliff at its base, the action of gravity causes great masses of material to fall down from the entire cliff face. Furthermore, when the clay is saturated with water, great portions of the cliff face slide down, entirely apart from the action of the sea or lake. At no time, then, is an eroding bluff any more stable than a naked dune.

It becomes evident from a survey of the bluff conditions that all vegetation is impossible so long as active erosion by the lake continues. Not only this, but vegetation at the top of the bluff is soon destroyed. *Fig. 30* shows a naked cliff of this

character ; at the top there can be seen overhanging turf, giving evidence both of the destructive action of the lake and also of the tenacity with which a grass mat holds its place in the presence of adverse conditions. Near the center of *fig. 31* may be seen a white oak which was almost overthrown by the erosive activities, but which has been preserved through the cessation of erosion at this point. The gully shown near the center of *fig. 30* is seen in closer view in *fig. 1;* the absence of vegetation, save that which has slid down from above, is very striking.

If for any reason the lake activities at the base of the cliff are stopped, an opportunity is offered for the development of vegetation. At Glencoe the cliff erosion has been checked to some extent by artificial means, and one can see various phases of cliff life within a small area. When the erosion at the base of the bluff ceases, conditions become much more stable, though landslide action may still occur. In time the slope gradient becomes so low that the cliff soil is essentially stable ; when this time arises vegetation develops with great rapidity in spite of the xerophytic conditions which are still as pronounced as before. It is very obvious, therefore, that it is the instability of the eroding cliff and not its xerophytic character which accounts for the absence of plant life.

The first vegetation is commonly made up of xerophytic herbs, both annual and perennial. Among these are the sweet clover (*Melilotus alba*), various annual weeds, various species of aster, especially *A. laevis*, *Equisetum hyemale*, various grasses, etc. Soon there develops a xerophytic thicket vegetation, such as is shown in *fig. 31*. This may be called the shrub stage of the captured cliff, and among the dominant species are the juniper and cedar (*Juniperus communis* and *J. Virginiana*), *Salix glaucophylla*, the osier dogwood (*Cornus stolonifera*), *Shepherdia Canadensis*, various sumachs (*Rhus typhina* and *R. glabra*). The following tree stage is dominated by various poplars (*Populus tremuloides*, *P. grandidentata*, *P. monilifera*), the hop hornbeam (*Ostrya Virginica*), the white pine (*Pinus Strobus*), the red cedar (*Juniperus Virginiana*), and some of the oaks (probably *Quercus*

rubra and *Q. coccinea tinctoria*). *Fig. 32* shows a tree-clad cliff in which most of the above trees are to be found.

Whether a mesophytic forest would develop on a lake bluff is something of a question. It seems likely that semi-xerophytic trees will dominate there for a long time to come on

FIG. 31.—Sea cliff at Glencoe, at a place where lake erosion has ceased. Shrubs (largely cedars and willows) prominent as well as herbs. Absence of lake erosion also indicated by the gentle slope, as compared with *fig. 30*. The leaning oak at the top bears witness to former erosive forces.

account of the xerophytic atmospheric conditions. Particularly at the top of the bluff do the conditions remain severe, by reason of the great exposure and also the dryness of the soil. If the lake should recede for some distance, a mesophytic forest could certainly develop on the bluff before it is reduced to anything like the common level. This is shown on the ancient lake bluff at Beverly hills. Here there is an old cliff about forty

feet above the country level, representing a lake bluff of the Glenwood stage of Lake Chicago.[24] This bluff has long had a mesophytic forest on its slopes, and yet it will be many centuries before the erosive forces remove all traces of this ancient sea

FIG. 32.—Sea cliff at Glencoe, where lake erosion has been absent for a long period. Xerophytic trees and shrubs, especially conifers, dominate, *e. g.*, white pine, red cedar, juniper.

cliff. A still more striking case is to be seen north of Waukegan, where an ancient lake bluff, higher than that at Beverly hills and only a mile back of the present lake shore is tenanted by a high grade type of mesophytic forest.

It will be instructive to make a few comparisons between lake bluffs and other plant societies. Closest to the lake bluff in a

[24] SALISBURY and ALDEN: The geography of Chicago and its environs. Chicago, 1899.

physiographic sense is the river bluff. When a stream has banks of clay the conditions seem decidedly similar and yet the flora is not the same. A comparison of the lake bluffs at Glencoe with the bluffs along Thorn creek shows that some species are common, notoriously Ostrya, Rhus, Quercus, Populus. Yet the differences are still more striking, for the bluffs along Thorn creek do not show *Salix glaucophylla* nor Shepherdia; most striking of all, however, is the entire absence of conifers. When we compare the lake bluffs with the rock bluffs of the Illinois river we find that the resemblances are greater than the differences, since the river bluffs have conifers, though even here some of the lake bluff forms are absent. When, however, we compare the Glencoe bluffs with the dunes, we find that all of the dominant shrubs and trees of the bluff are found also on the dunes; not only this, the dominant bluff forms are dominant on the dunes also.

The facts of the preceding paragraph are pregnant with significance. One obvious corollary is that given similar soils but dissimilar conditions of atmospheric exposure, as at Glencoe and Thorn creek, the vegetation is unlike. Another and more striking corollary is that given the most dissimilar soils possible, viz., the Glencoe clay and the dune sand, we still have similar vegetation, because the atmospheric conditions are the same in the two cases. The evidence of the Illinois river bluffs is less clear; they are more xerophytic than the bluffs along Thorn creek, but whether this is chiefly due to rock as against clay or to greater exposure is not certain. At all events these facts show that it is not enough to know about chemical or physical conditions in the soil. We cannot divide plants into those of clay, rock, and sand, but must take into account that most plants have a wide range of life so far as soil is concerned, provided the atmospheric conditions are congenial. The chief exception to this statement seems to be found not in the original soils but in the superimposed humus. There are many plants that require humus for their occurrence in nature, but it makes no difference whether the subsoil is rock, sand, or clay, provided alone that

the humus is present in sufficient quantity. It is by reason of this last fact that the mesophytic forest can appear in all conditions in this climate, since the mesophytic forest is associated to a high degree with humus.

2. THE BEACH-DUNE-SANDHILL SERIES.

A. *The beach.*—The author has previously discussed in considerable detail the dynamics of the dune societies,[25] and it will not be necessary to do more here than to summarize the chief conclusions, and add a few new data. Before long it is expected that a paper will appear giving the changes that have taken place since the first observations were made in 1896.

The beach in the Chicago area is xerophytic throughout. There is nothing analogous to the salt marshes of the Atlantic coast, nor to the hydrophytic shores farther north along Lake Michigan. The lower portion of the beach is exposed to alternate washing by the waves and desiccation in the sun, and is devoid of life. The middle beach, which is washed by winter waves, though not by those of summer, has in consequence a vegetation of xerophytic annuals, the most prominent of which is *Cakile Americana*. The upper beach is beyond present wave action, and is tenanted by biennials and perennials in addition to the annuals. *Fig. 33* shows a beach of this type, the lower beach being smooth and even, the middle beach covered with débris, while the upper beach has a scattered perennial vegetation.

The beach at the base of cliffs shows similar subdivisions, though the zones are much narrower as a rule. The vegetation, too, is much the same, though some forms, as Strophostyles, have not been seen as yet on the beaches of the dune district. At the foot of cliffs there often occur alluvial fans of sand, which have been deposited by the torrents during and following rain storms. These fans have a comparatively rich vegetation and species sometimes occur here that are not found elsewhere on the beach.

[25] COWLES, H. C.: The ecological relations of the vegetation on the sand dunes of Lake Michigan. BOT. GAZ. **27**: 95–117, 167–202, 281–308, 361–391. 1899.

B. *The embryonic or stationary beach dunes.*—Wherever plants occur on a beach that is swept by sand-laden winds, deposition of sand must take place, since the plants offer obstacles to the progress of the wind. If these plants are extreme xerophytes and are able to endure covering or uncovering without injury, they may cause the formation of beach dunes. Among the

FIG. 33.—Beach at Dune park, showing the smooth and naked lower beach, the middle beach with its line of débris, the upper beach with scattered shrubs, and the dunes.

dune-forming plants of this type are *Ammophila arundinacea*, *Salix glaucophylla* and *S. adenophylla*, *Prunus pumila*, and *Populus monilifera*. The shapes of these beach dunes vary with the characteristics of these dune-forming plants. Ammophila dunes are extensive but low, because of strong horizontal rhizome propagation. Prunus and Populus dunes are smaller but higher, because of the relative lack of horizontal propagation and the presence of great vertical growth capacity. Dunes are formed more slowly in protected places, and here the dune-forming species may be plants that are ill adapted to the severest beach conditions, such as the creeping juniper.

C. *The active or wandering dunes. The dune complex.*—The stationary embryonic dunes on the beach begin to wander as soon as the conditions become too severe for the dune-forming plants. The first result of this change is seen in the reshaping of the dune to correspond with the contour of a purely wind-made form. The rapidity of this process is largely determined by the success or failure of the dune-formers as dune-holders. The best dune-holders are Calamagrostis, Ammophila, and Prunus.

There are all gradations between a simple moving dune and a moving landscape; the latter may be called a dune-complex. The complex is a restless maze, advancing as a whole in one direction, but with individual portions advancing in all directions. It shows all stages of dune development and is forever changing. The windward slopes are gentle and are furrowed by the wind, as it sweeps along; the lee slopes are much steeper. The only plant that flourishes everywhere on the complex is the succulent annual, *Corispermum hyssopifolium*, although *Populus monilifera* is frequent. The scanty flora is not due to the lack of water in the soil, but to the instability of the soil and to the xerophytic air.

The influence of an encroaching dune upon a preexisting flora varies with the rate of advance, the height of the dune above the country on which it encroaches, and the nature of the vegetation. The burial of forests is a common phenomenon. The dominant forest trees in the path of advancing dunes are *Pinus Banksiana* and *Quercus coccinea tinctoria*. These trees are destroyed long before they are completely buried. The dead trees may be uncovered later, as the dune passes on beyond.

In the Dune park region there are a number of swamps upon which dunes are advancing. While most of the vegetation is destroyed at once, *Salix glaucophylla*, *S. adenophylla*, and *Cornus stolonifera* are able to adapt themselves to the new conditions, by elongating their stems and sending out roots from the buried portions. Thus hydrophytic shrubs are better able to meet the dune's advance successfully than any other plants. The water relations of these plants, however, are not rapidly altered in the new conditions. It may be, too, that these shrubs have

adapted themselves to an essentially xerophytic life through living in undrained swamps. Again it may be true that inhabitants of undrained swamps are better able to withstand a partial burial than are other plants.

Vegetation appears to be unable to capture a rapidly moving dune. While many plants can grow even on rapidly advancing slopes, they do not succeed in stopping the dune. The movement of a dune is checked chiefly by a decrease in the available wind energy, due to increasing distance from the lake or to barriers. A slowly advancing slope is soon captured by plants, because they have a power of vertical growth greater than the vertical component of advance. Vegetation commonly gets its first foothold at the base of lee slopes about the outer margin of the complex, because of soil moisture and protection from the wind. The plants tend to creep up the slopes by vegetative propagation. Antecedent and subsequent vegetation work together toward the common end. Where there is no antecedent vegetation, Ammophila and other herbs first appear, and then a dense shrub growth of Cornus, Salix, *Vitis cordifolia*, and *Prunus Virginiana*. Capture may also begin within the complex, especially in protected depressions, where *Salix longifolia* is often abundant.

D. *The established dunes.*—No order of succession in this entire region is so hard to decipher as is that of the established dunes. There are at least three types of these dunes so far as the vegetation is concerned, and it is not yet possible to figure out their relationships. The continuation of the conditions as outlined in the preceding paragraph results in a forest society on the lee slope, in which is found the basswood, together with a most remarkable collection of mesophytic trees, shrubs, and climbers, which have developed xerophytic structures. These dunes are evidently but recently established, as is shown by the absence of a vegetation carpet; furthermore the slopes are almost always steep.

Again, there are forest societies in which the pines dominate, either *Pinus Banksiana* or *P. Strobus*. These arise from a heath, composed in the main of Arctostaphylos and Juniperus. The

heath appears to originate on fossil beaches or on secondary embryonic dunes or other places where the danger of burial is not great. It will be noted that both the heath and the pine forest are dominated by evergreens. These societies commonly occur near the lake or on lakeward slopes, which are northern slopes as well. On these coniferous dune slopes there is to be found another notable collection of northern plants, resembling ecologically the peat bog plants already mentioned. Heaths and coniferous forests also occur on sterile barrens and in depressions where the conditions are unfavorable for deciduous forests. A slight change in the physical conditions may bring about the rejuvenation of the coniferous dunes, because of their exposed situation. This rejuvenation commonly begins by the formation of a wind sweep, and the vegetation on either hand is forced to succumb to sand-blast action and gravity.

A third type of established dune is that in which the oaks predominate, and especially *Quercus coccinea tinctoria*. The oak dunes are more common inland and on southern slopes. Probably the oaks follow the pines, but the evidence on which this is based is not voluminous. The pines certainly have a wider range of habitat than the oaks, occurring in wetter and in drier soil and also in more exposed situations. The mutual relations of the pines and oaks are certainly interesting and deserve some very careful study. Pine forests prevail on the north or lakeward slopes and oak forests on the south or inland slopes. With the pines are other northern evergreen forms, such as Arctostaphylos, while with the oaks are Opuntia, Euphorbia, and other more southern types. The density of the vegetation on the north side is also in contrast with the sparser and more open vegetation of the south side. The cause for this radical difference on the two slopes is doubtless complex, but it is obvious that the north slope has greater moisture, shade, and cold, and probably more wind. Which of these is the more important is not certain, but the presence of the northern species seems in favor of cold or wind as the chief factor.

There are a number of interesting sand hills and ridges at

some distance from the lake. Some of these are fifteen miles from the present lake shore, while others are found at various intervals nearer and nearer the lake. It has been found that these can be grouped for the most part into three series, representing three beach lines of Lake Chicago, as the glacial extension of Lake Michigan has been called. The upper and oldest

FIG. 34.— Portion of an ancient beach line (Calumet beach) at Summit, showing the characteristic oak vegetation, in this case chiefly bur oaks (*Quercus macrocarpa*).

of these ridges has been termed the Glenwood beach, the intermediate ridge the Calumet beach, and the lower and younger ridge the Tolleston beach. The geographic relations of these beaches is well discussed by Leverett[26] and also by Salisbury and Alden,[27] and nothing need be said here except as to the vegetation. In general these ridges and hills have a xerophytic forest flora, dominated by the bur, black, and white oaks (*Quercus macrocarpa*, *Q. coccinea tinctoria*, *Q. alba*). The proportions between these trees varies strikingly, though the bur or

[26] *Op. cit.* 55–85. [27] *Op. cit.* 31–51.

black oak is usually the chief character tree. No satisfactory reason can yet be given for these variations, though the bur oak appears to be more abundant on the lower and less drained ridges, while the black oak is more abundant on the higher ridges. The shrub undergrowth is commonly sparse, and the most frequent members of this stratum are the hazel (*Corylus*

FIG. 35.— Portion of an ancient beach (Glenwood beach) near Thornton. The trees here are chiefly black oaks (*Quercus coccinea tinctoria*); the beach is higher, and the trees more luxuriant than usual.

Americana), Rosa, the New Jersey tea (*Ceanothus Americanus*), *Salix humilis*, the low blueberry (*Vaccinium Pennsylvanicum*), and the huckleberry (*Gaylussacia resinosa*). Among the commoner herbs are *Silene stellata*, *Antennaria plantaginifolia*, *Heuchera hispida*, *Rumex Acetosella*, *Carex Pennsylvanica*, *Potentilla argentea*, *Poa compressa*, *Pteris aquilina*, *Ceratodon purpureus*. In open places there are often almost pure growths of Poa or Potentilla. *Figs. 34* and *35* show portions of these ancient beaches in which the oaks dominate; *fig. 34* shows, perhaps, the more common condition, *i. e.*, a rather low beach with a sparse tree growth.

The future of the vegetation on the established dunes and beaches is somewhat problematical. From analogy with other plant societies in this region, and from established dunes in Michigan, we should expect a mesophytic forest, probably of the white oak-red oak-hickory type at first and then followed by a beech-maple forest. There are evidences that some such changes are now taking place. On many of the oak dunes, especially where protected from exposure, there is already a considerable accumulation of humus. Herbaceous ravine mesophytes like Hepatica, Arisaema, and Trillium are already present, and with them mesophytic shrubs and trees, including the sugar maple itself, though the beech has not been found on the dunes of our area, as it has in Michigan. One might expect that the flora of the older Glenwood beach would have advanced more toward the mesophytic stage than has the flora of the younger Tolleston beach. Such, indeed, seems to be the case, especially at Glenwood, where the white oaks are more numerous, and the black oaks much larger and more luxuriant. The humus is richer and most things look as if the age of this beach were notably greater than that of the Calumet or Tolleston beaches. This subject, however, needs much further investigation. In any event, one character of the sand hill stands out in bold relief, viz., its great resistance to physiographic change. Not only is its erosion slower than that of the clay hill, but the advance of its vegetation is vastly slower at all points along the line. The slowness of humus accumulation accounts for this, perhaps, more than all else.

III. Summary and conclusion.

In the present paper the author has endeavored to show the need for a classification of plant societies which shall form a logical and connected whole. Warming's classification, based on the water content of the soil, is doubtless the best possible classification, if but one factor is used. Graebner's classification, based on soil characteristics, includes the advantages of Warming's scheme, and adds desirable new features.

The physiographic theory here presented is the result of several years of field study devoted chiefly to testing the current theories and to developing new ones. The classification is based on the fundamental notion that a true theory must be genetic and dynamic; the plant societies must be grouped according to origins and relationships, and the idea of constant change must be strongly emphasized.

The laws that govern changes in plant societies are mainly physiographic; whether we have broad flood plains, xerophytic hills, or undrained swamps depends on the past and present of the ever-changing topography. Nor is topographic change haphazard. Modern physiography has made a logical classification of dynamic surface forces, and has found a progressive tendency toward a definite end. Denudation of the uplands and deposition in the lowlands results in an ultimate planation, known as the base level. Wherever hills are being eroded, or lakes filled, or coastal plains enlarged, it is obvious that there must be changing plant societies, in other words, a definite order of succession of plant groups. These changes, too, are cumulative; a topographic form will have plants that are relicts of an older stage, as well as those that are typical of the new conditions, showing that the supplanting of one plant society by another is slow and gradual. The full effect of a given environment may not be felt till that environment has gone.

Using ecological terms in place of those of physiography, soil conditions tend to become more mesophytic as the base level develops. A young topography is rich in xerophytic hills and in hydrophytic lakes and swamps. There may be local retrogressions toward xerophytic or even hydrophytic plant societies, forming eddies, as it were, but the great movement is ever progressive and toward the mesophytic condition. Though instances of vast planation are found in geological history, the ultimate mesophytic base level is seldom reached, since crustal movements interfere with physiographic processes. So far as plants are concerned, however, a physiographic terminology may still be used, since all possible crustal changes are either toward or

away from the mesophytic, *i. e.*, progressive or retrogressive. Again, climatic changes doubtless occur; even here we may use the general terminology, since the new conditions either favor or retard the general mesophytic development. This leads to the general view that the climax type differs with the climate. While the general series of physiographic changes is much the same everywhere, the corresponding plant societies are vastly different. In a desert climate most of the societies, including the climax type itself, are xerophytic. Finally, there is at least one point where physiographic and ecological classifications must diverge. Changes in vegetation often take place where the topography remains the same; in other words, a cycle of vegetation may be shorter than a cycle of erosion. The following application of these principles applies only to the Chicago region.

The typical erosion series is based on the life history of rivers, and this series is the most instructive ecologically. An embryonic clay ravine is essentially a little desert, though this character is due more to the instability of the soil than to the ordinary xerophytic factors. Soon landslide action becomes much reduced, and a xerophytic flora may appear, though in a remarkably short time a rich mesophytic forest is developed. This forest is not permanent, but may be regarded as a temporary climax. Rock ravines, whether of limestone or sandstone, commonly have more vertical slopes and drip with moisture, favoring the growth of extreme shade plants. The stages in limestone and sandstone habitats are essentially the same in spite of great physical and chemical differences in the rock.

As a clay ravine widens, the exposure increases; xerophytic herbs appear at the top of the slope, and later farther down toward the stream bed. Xerophytic shrubs and finally xerophytic trees make their appearance, notoriously *Ostrya Virginica.* In the early stages of these xerophytic bluffs trees are often found that look back to the ravine for their origin, while under them are xerophytic herbs that are better suited to the new conditions. As the slopes of a mesophytic rock ravine pass to a xerophytic rock bluff, changes in the vegetation are most pronounced. A

slope less xerophytic than that of clay becomes more xerophytic as it becomes a river bluff, and conifers are found as well as deciduous xerophytes. As the bluff slopes become more gentle through erosive action, a mesophytic flora may gradually replace the xerophytes.

Before the growing valley possesses a permanent stream there may be developed in the torrent bed a vegetation of amphibious shade plants, and when the water becomes more permanent one may find algae and other hydrophytes. Spring brooks are infrequent, but they have a characteristic vegetation, due doubtless to the presence of more light and water. The development of a flood plain vegetation is well shown on river islands. First a sand bar develops, then an annual flora, and later a perennial vegetation in which Salix dominates. The river constantly erodes above and deposits below, hence the islands migrate down the stream, showing the oldest plant societies at the upper end. Depositing streams gradually develop a flood plain which shows an interesting succession of societies. Beyond the true hydrophytes there is commonly seen a Salix zone, then a zone of Populus and other trees on the older flood plain, and finally there develops a luxuriant mesophytic flood-plain forest which as a whole is permanent, though local retrogressions may occur. In some of these flood-plain forests there are found interesting southern types of trees. Occasionally meadows occur on flood plains in place of forests. Retrogressive processes are active on flood plains, such as terrace formation, which is due to further erosion; terrace development tends to favor xerophytes. New channels are also cut off, leaving portions of the old river as oxbow lakes; here hydrophytes of undrained swamps come in, and one often sees trees of the old river margin together with shrubs and herbs of the undrained swamps. These latter phases, however, are ephemeral and the mesophytic flood plain as a whole increases constantly in area.

The vegetation of undrained areas has a remarkably xerophytic stamp; this is possibly due to the unfavorable opportunity for root activity in undrained soils. In any event, these

areas are features of a young typography and they are soon filled up by accumulating peat. Algae and other hydrophytes characterize the lake or pond stages, and largely by their partial decay the water becomes shallow enough to support the vegetation of a marginal swamp, particularly rushes and sedges. After these forms there appear the most remarkable plant societies of the entire series, characterized chiefly by Cassandra and other ericads with xerophytic structures. Following the shrub stage there is the tree stage in which the tamarack often dominates, though pines appear later and ultimately mesophytes. In these swamps one finds the most perfect examples of the regular succession of plant societies, and hence of zonal arrangement. These peat bog societies contain a most striking collection of northern plants. There are various diverging types of undrained swamps, some with shallow soil and a vegetation without extreme xerophytic structures, others in which an imperfect drainage may account for the facts observed. The marginal vegetation is the same in all cases and is remarkably characteristic; this flora is sometimes seen after the lake and swamp floras have gone. Half-drained areas are characterized by luxuriance of the vegetation in the lake stage. The lake is followed in order by the bulrush, sedge, and grass stages, the latter being denominated the prairie stage. Whether this latter type passes into the forest is not certain; in any event, this mesophytic stage is not final, for the region must subsequently pass through the stages of the river series.

Uplands, as well as swamps, have an interesting history before they are attacked by stream erosion. Limestone hills and outcrops show first a lichen vegetation, followed by mosses and crevice herbs and later by shrubs and trees. The stages on clay hills pass far more rapidly, indeed early stages are hard to detect, and one almost uniformly finds a mesophytic forest of oaks and hickories in these habitats. Where the forest conditions are disturbed, there is a rapid return through a series of herb and shrub stages to the same tree types. It is somewhat probable that the oaks will be followed by sugar

maples and beeches, and this change is now occurring in some places. The mesophytic stage here also is not permanent, though it may endure for a long period.

Clay bluffs along an eroding coast are subject to considerable change involving the rapid destruction of upland vegetations. The changes, too, are so rapid that practically no vegetation can develop on the bluff slopes. If the erosive activity of the lake ceases, there soon appears a vegetation of xerophytic herbs, followed by xerophytic shrubs and trees in which conifers play a large part. There is a notable resemblance between the flora of the clay bluff along the lake shores and the flora of the sand dunes, and also the flora of rock bluffs along rivers, while the resemblance is less close to the flora of clay bluffs along rivers, showing that soil conditions may often be less important than conditions of aerial exposure.

The dune vegetation, presented in detail elsewhere, is summarized in this present paper. Nothing need be said in the way of further summary except to remark that dunes, like all other topographic forms in our climate, may ultimately develop a mesophytic forest, though the stages are far slower than in most of the other series.

THE UNIVERSITY OF CHICAGO.

SOME RECENT PUBLICATIONS AND THE NOMENCLATORIAL PRINCIPLES THEY REPRESENT.

M. L. FERNALD.

THE second edition of Mr. Heller's *Catalogue*[1] presents, as a piece of presswork, a great improvement over its predecessor. For thus materially improving the dress of his work the author is certainly to be commended. The book also contains a very large increase of species over the first edition; and for bringing together hundreds of recently published names, where they can be readily consulted, the compiler should have the gratitude of students of systematic botany. In a work of this sort, necessarily accomplished largely by compilation, monographic treatment of recent and doubtful species can not and should not be expected; but there can be no question that the compiler of a check list or catalogue owes to the public the product of the best light he has upon the species with which he deals. Mr. Heller's new *Catalogue*, especially, representing the so-called reform tendencies in American botany, should be judged primarily by the degree of adherence to or divergence from the principles which he has taken upon himself to exploit. This second edition, too, should be judged by the degree of readiness shown by its author to correct such obvious errors and inconsistencies in his preceding work as have been definitely called to his attention in print.

It is a question which is the point of greater significance to systematic botany — the hopeless tangle of nomenclatorial principles here exhibited, or the tendency, by no means new, to break through the traditional though necessarily vague barriers separating the minor categories to which plant-variations may be assigned, namely, the species, variety, and form. That the author of this *Catalogue*, and numerous other American botanists,

[1] Catalogue of North American plants north of Mexico, exclusive of the lower cryptogams. By A. A. HELLER. Second edition. Issued November 10, 1900.

like Jordan and others in Europe, have essentially abandoned these finer discriminations in classification, has been made perfectly evident in their past work, and now we are informed that "there is also a growing tendency to discard the use of varietal names, and to call all plants species which have characters enough to justify the use of a distinctive name."[2] To the critical student, who is familiar with growing plants and the causes which so often control their variations, such action as this cannot appeal; and, though the author of the *Catalogue* is not alone in his standpoint, there are still many students whose conceptions of plants and their relationships can be expressed only by the retention of categories which are subordinate in rank to the species.

However, even if, by putting essentially all variations within the genus upon a common level, the author chooses to obscure the minor degrees of relationship in plants, there should be no question of personal choice or opinion in judging the method so often adopted by him in order to increase the number of so-called species. In the introduction to the new *Catalogue* (as well as in the original edition) many new combinations of names are made; but, finding that space would not permit the publication there of all the changes he desired to make, the author has ventured a new private journal,[3] the first issue of which is occupied by an appendix to the nomenclatorial changes begun in the *Catalogue*. It seems that the author has, or did have on November 10, 1900, some conception of the unsatisfactory methods he was employing, for in apologizing for so proceeding he says: "The bare citation without discussion in most cases is *undesirable*, but *lack of time* forbids a more extended treatment of the different species under *consideration* [italics ours]."[4] Does anyone suppose that by careful botanists such an apology can be accepted as a pledge of sincere desire to advance botanical science; or can it be that

[2] HELLER, *l. c.* 3.

[3] Muhlenbergia, a Journal of Botany. Edited and Published by A. A. HELLER, Lancaster, Pa.

[4] HELLER, *l. c.* 1:1.

the author conceives that *his time*, the "lack" of which alone permits him to launch so many *unconsidered* species, is of far greater importance than that of the scores of other botanists who must now spend weary hours trying to unravel the snarls he has produced? An example or two may make our point more clear. The names *Prenanthes Serpentaria* and *Nabalus Serpentarius* have been essentially interchangeable in American floras,[5] and the name in either case has been made to cover until recently two very different species. In the *Illustrated Flora*, however, Dr. Britton has revived Cassini's *Nabalus trifoliolatus* for a well-marked northern plant, and has left the name *N. Serpentarius* to cover (as it should) the thick-leaved species of more southern range with the "involucre more or less bristly-hispid." Torrey and Gray described *Nabalus Fraseri*, var. *barbatus*, with the "involucre (12–15-flowered) hirsute when young with long purplish hairs," and in the *Synoptical Flora*, Dr. Gray, writing at a time when the name *Prenanthes Serpentaria* covered the northern plant with usually glabrous involucre, published *P. Serpentaria*, var. *barbata*, with the remark that "occasionally a few of these setose hairs are found on the involucre of ordinary *P. Serpentaria*, and in this variety [*barbata*] some heads are almost destitute of them." Now the original Torrey and Gray specimen of this variety is in no way different from the species, *Nabalus Serpentarius*, as correctly interpreted by Dr. Britton. Nevertheless, we have in *Muhlenbergia* (1:8) the new combination *Nabulus barbatus* (T. & G.) Heller, although in the *Catalogue* both *N. Serpentarius* and *N. trifoliolatus* are listed. Again, *Ilex verticillata*, forma *chrysocarpa*, noted by Dr. Robinson in Rhodora (2:106), appears in the new *Catalogue* as "[var.] *chrysocarpa* Robinson." The original specimen in the Gray Herbarium has never been borrowed by the author of the *Catalogue*, and it is perhaps elevated by him to varietal rank through carelessness; but now that it is listed as a variety it will be interesting to see how soon it will be erected to a species by one who believes in calling "all plants species which have

[5] In this paper these names may be thus accepted without discussion as to their status.

characters enough to justify the use of a distinctive name," and who, like him, knows the plant only from the descriptive phrase "fruit bright yellow." These two cases are sufficient to show the character of work which can be done by one who believes in making all the new combinations possible, when he is handicapped by "lack of time" to consider his work, and who apparently holds it more important to launch a mass of ill-considered (and often to him unknown) species than to publish only the results of critical and scholarly consideration.

If in thus launching so many species (and occasional varieties) of which he can have little or no personal knowledge, the author were producing combinations consistent with the names in the remainder of his book, his reason would be obvious and to some extent justifiable. But only a slight examination of the names taken up is sufficient to show that he has had little conception of any clearly defined principle to govern his selection of names. Professedly the names in his work, like those in the Botanical Club *Check List* and in Britton and Brown's *Illustrated Flora*, are based upon the principle of strict priority; but the result, as shown here perhaps even more than in those works, gives us little assurance that the publications on such a basis are bringing us the uniformity which has been so loudly proclaimed and which every one would so gladly welcome.

In the first group of plants listed, for instance, the Pteridophyta, the names essentially as defined by Professor Underwood[6] are taken up. Professor Underwood is one of the few authors among the radical botanists who has squarely faced the strict priority question, and in his selection of generic types he has attempted to follow the logic of his course to the bitter end. Thus, as the type of the genus he takes the first species described under the generic name, so long as the same plant does not belong to some previously defined genus. In such a case he logically takes for the generic type the first species which is clear from all previous genera. However much one may differ from him as to the expediency of such a course, it is indeed a

[6] Our Native Ferns and their Allies. Ed. 6. 1900.

satisfaction to know that at least one follower of the Rochester Code is ready to show us the actual task and the enormous upsetting of names consequent upon a conscientious and logical working out of the principle of strict priority.

In Mr. Heller's *Catalogue* many of the names accepted are not those which can be used consistently by authors who are committed to the Rochester Code. When that code was proposed it was professedly with the purpose of establishing uniformity in our nomenclature. As an outgrowth of its adoption by some American botanists the Botanical Club *Check List* was issued, a list which aimed to give us the names which our northeastern plants must henceforth bear according to the rulings of strict priority principles. That publication gave us the first tangible result upon which to base our estimate of the workings of the code; and though by some thoughtful and conservative students the book and the principles represented by it were carefully discussed, by other botanists the publication was hailed as "the sign that the day of 'authority' as such is ended, and the day of 'law' has begun,"[7] and we were informed that "even the most obscure botanist is nowadays entitled to know why an old plant comes out under a new name . . . . and that their [the compilers of the *Check List*] work is plain work, the plain and straightforward statement of facts."[8]

It is pertinent, then, for "the most obscure botanist" to ask about some of the names now (at least at the time of this writing) in vogue among those who champion the Rochester Code, and we may be permitted to inquire of those who have been instrumental in bringing about the present "uniformity" how they account for a few of the names in their pages. Reference has already been made to Professor Underwood's treatment of the ferns partially adopted by Mr. Heller in his *Catalogue*. In Britton and Brown's *Illustrated Flora*, published in 1896, 59 species of true ferns are recognized, and the names, we are told, are those authorized by the Rochester Code. But in Professor Underwood's latest treatment more than *25 per*

[7, 8] BESSEY, C. E.: Am. Nat. **29**: 350.

cent.[9] of those very species appear under different names — still the names authorized by the Rochester Code. For the benefit of those not familiar with these works, but who have an interest in seeing the working of the same rule in the hands of one of its strong advocates, the fifteen northeastern species which have recently appeared under new names are here enumerated:

Names in Britton and Brown's *Illustrated Flora* (1896), based upon the Rochester Code.	Names in Underwood's *Our Native Ferns and their Allies* (1900), based upon the Rochester Code.
Onoclea Struthiopteris (L.) Hoffm.	*Matteuccia struthiopteris* (L.) Todaro.
Dicksonia punctilobula (Michx.) A. Gray.	*Dennstaedtia punctilobula* (Michx.) Bernh.
Cystopteris bulbifera (L.) Bernh.	*Filix bulbifera* (L.) Underwood.
" *fragilis* (L.) Bernh.	" *fragilis* (L.) Underwood.
" *montana* (Lam.) Bernh.	" *montana* (Lam.) Underwood.
Dryopteris Lonchitis (L.) Kuntze.	*Polystichum lonchitis* (L.) Roth.
" *acrostichoides* (Michx.) Kuntze.	" *acrostichoides* (Michx.) Schott.
" *Braunii* (Spenner) Underwood.	" *Braunii* (Spenner) Lawson.
Phegopteris Dryopteris Robertiana (Hoffm.) Davenp.	*Phegopteris Robertiana* (Hoffm.) Underwood.
Scolopendrium Scolopendrium (L.) Karst.	*Phyllitis scolopendrium* (L.) Newm.
Asplenium acrostichoides Sw.	*Asplenium thelypteroides* Michx.
Pteris aquilina L.	*Pteridium aquilinum* (L.) Kuhn.
Pellaea Stelleri (S. G. Gmel.) Watt.	*Cryptogramma Stelleri* (Gm.) Prantl.
Cheilanthes gracilis (Fée) Mett.	*Cheilanthes Feei* Moore.
Notholaena nivea dealbata (Pursh) Davenp.	*Notholaena dealbata* (Pursh) Kunze.

That the names recently used by Professor Underwood are more truly consistent with the strict priority principles than many names in other groups listed by Mr. Heller has been already emphasized. But why, we would ask, are there so many unexplained inconsistencies in this new *Catalogue*, especially when the attention of followers of the Rochester Code has

[9] The true ferns alone are here considered, and the genus *Botrychium* is purposely omitted, since that genus has been subdivided by Professor Underwood to such an extent that comparative figures would have little definite significance.

been called to a number of such erroneous matters? A very typical example of the inconsistent method (or lack of method) employed in the *Catalogue* is shown in the treatment of the genera *Cheiranthus* (*Erysimum* of authors), *Erysimum* (*Sisymbrium* of authors), and *Sisymbrium* (*Nasturtium* and *Roripa*[10] of authors). Professor E. L. Greene[11] pointed out, in December 1896, the only logical and consistent course to be followed, according to strict priority principles, in the cases of *Cheiranthus* and *Erysimum*. Mr. Howell[12] has followed his lead, and in a recent article the same point[13] was further emphasized. There is, then, no reason why the authors of the second volume of the *Illustrated Flora*, published May 31, 1897, and of the *Appendix*, published June 20, 1898, should have been ignorant of Professor Greene's logical article. But why did they ignore his conclusions and use names in a sense absolutely inconsistent with the

[10] The so-called reformers persist in writing *Roripa* instead of the original form, *Rorippa*, and they say *Bicuculla* instead of the original form, *Bikukulla*, although the matter has been freely discussed in the past, and by this time they should be aware of the facts in the case. But, on the other hand, after using the name *Koniga*, they now take up the original *Konig*. If in one case they adopt the original spelling, why not in the others? Is this what they consider a consistent method, and does it appeal to them as "the plain and straightforward statement of facts?" We should like to inquire also about the name which, in the publications of the reformers, has recently taken the place of *Mikania* Willd. In the Botanical Club *Check List* we have a name attributed to Necker and spelled *Willoughbya*, with the footnote remark "*Willoughbaeya* in original;" but in the *Illustrated Flora* the name is spelled *Willughbaea*, and we are informed that the plant was "probably named in honor of Francis Willoughby, 1635–1672, English naturalist, but the name spelled by Necker as above [*Willughbaea*]." This spelling is, therefore, faithfully followed in Mr. Heller's *Catalogue*. Otto Kuntze enumerates in his *Revisio Generum Plantarum* some "incorrect ways of writing the name" as follows: "*Willugbaeya, Willoughbeia, Willughbeia, Willoughbeja, Willugbeia, Willughbeja, Villughbeia.*" Poor Necker, himself, if he were living, would indeed be dazed, particularly as his name was unlike either of those definitely asserted by Dr. Britton to be correct, and since, on the contrary, the true and original form *Willugbaeya*, is the *first* form enumerated by Kuntze as "incorrect." From these facts it would seem that to some botanists whose work is controlled by "law" such divergence from the original spelling is of slight moment. If so, will they be good enough to make clear why *Mikania* is rejected for *Willugbaeya* and its variations (1790), when in 1789 Scopoli published *Willughbeja* (compare Otto Kuntze above), a genus of the *Apocynaceae?*

[11] Pittonia 3: 128.

[12] Fl. N. W. Am. 1: 38–56. [13] ROBINSON, B. L.: BOT. GAZ. 25: 439–442.

spirit and rulings of their own Rochester Code, especially when, as we were informed in 1895 by one of the *Check List* committee, "the committee . . . . . would still be grateful . . . . . for useful suggestions on these matters, and that all communications of this kind would receive fair hearing and sober judgment."[14] There is, furthermore, no possible reason why the author of the *Catalogue* which suggested this discussion, should have been, in 1900, uninformed of the publications on the subject. In fact, perhaps unconscious of the thoroughly inconsistent course he was taking, he has followed one third of the suggestions made and has adopted for the conventional *Erysimum* of authors the name *Cheiranthus*; but he still clings to the names *Sisymbrium* and *Roripa* for genera to which they cannot be applied by conscientious followers of strict priority principles dating from 1753.

Another point in regard to generic names pointed out in one of the articles cited[15] is in the case of *Cerastium* and *Stellaria*. It was there clearly shown that when the first part of the Linnaean *Stellaria* was transferred by the reformers to *Alsine* (a course not entirely free from question), one species was still left in *Stellaria*, namely, *S. cerastioides* L. This plant is treated by modern authors as a *Cerastium*, and in the Botanical Club *Check List*, the *Illustrated Flora* and in Mr. Heller's new *Catalogue* it appears as *C. cerastioides* (L.) Britton. But in the *Species Plantarum* of Linnaeus *Stellaria* preceded *Cerastium*, and therefore the portion of *Stellaria* (*S. cerastioides*) left when the remainder was transferred to *Alsine* should, according to the strict priority principle, become the type of *Stellaria*, and the succeeding genus *Cerastium* should be absorbed by it. Why, then, after this matter was clearly pointed out in June 1898, does the author of the *Catalogue*, who does not hesitate to launch a lot of new combinations based upon plants of whose status he is much less certain, still keep up the name *Cerastium* in its traditional sense?

The familiar vine known to most of us as *Wisteria* is listed in the

[14] COVILLE, F. V.: BOT. GAZ. **20**: 164.

[15] ROBINSON, B. L.: BOT. GAZ. **25**: 444, 445.

Catalogue as *Kraunhia frutescens* (L.) Greene (though that name was first published by Rafinesque in 1808); but the recently described *Apios Priceana* Robinson is given without change of name. The author of the *Catalogue* must admit that he knew of the publication of the latter plant, else how could he include it in his *Catalogue*. But will he inform us how it happens that he has ignored the facts presented in the original discussion,[16] of that species? Was it not shown as clearly as could be desired by anyone that the names *Apios* Moench (1794) and *Kraunhia* Rafinesque (1808) were both antedated by *Bradlea* Adanson (1763)—a name applied to two Linnaean species of *Glycine*, *G. Apios* (*Apios tuberosa* Moench), and *G. frutescens* (*Wisteria frutescens* Poir.) now referred by the reformers to *Kraunhia?* And was it not made clear that by those who would follow the Rochester Code the name *Bradlea* must be taken up for *Apios?* How does the author of the *Catalogue*, who lists *Apios Priceana*, explain his failure to stand by the principles he claims to follow?

There are many other generic names accepted by the reform botanists and now adopted in this *Catalogue*, which, according to the rules to which they have committed themselves, have no better status than those pointed out. But the few cases already explained in the past and here again emphasized are sufficient to show him who cares to examine the original references that the member of the *Check List* Committee, who, in 1895, wrote that "all communications of this kind would receive fair hearing and sober judgment" could not have been speaking for all the members of the committee, nor indeed for many whose prolific writings have done more than anything else to stultify the rules of which they claim to be true advocates. That such absolute recklessness in the application of these rules is not satisfactory to all members of the *Check List* Committee is occasionally made apparent. Professor Underwood's position in regard to fern names has been remarked; and another of the committee has thus expressed himself: "Why are some of us so openly at war with our own rules? Certainly no rule relating to the

[16] ROBINSON, B. L.: BOT. GAZ. **25**: 452.

observance of priority has been more generally recognized and deferred to than this, that a genus, as to its name at least, stands or falls with its type species; no rule is more indispensably necessary; and nothing but endless change and confusion can come of the neglect of it."[17]

Numerous inconsistencies as to the treatment of species as well as genera have been publicly pointed out; yet here, as in case of some other perfectly just and logical criticisms, the effort seems to have been wasted upon those who are bringing us "the day of 'law.'" In a review[18] of the first edition of the *Catalogue* attention was called to some of these specific names. *Anoda lavaterioides* Medic., for instance, as there intimated, has a Linnaean synonym in *Sida cristata*, while *Arenaria sajanensis* Willd. is the same as the Linnaean *Stellaria biflora* (*Arenaria biflora* (L.) Watson, which is the name accepted by Dr. Britton). Yet in spite of these very clear cases which have been emphasized in print, the second edition of the *Catalogue* follows the first in giving *Anoda lavateroides* [*lavaterioides*] and *Arenaria Sajanensis*. By what "law" are these names reconciled with the Rochester Code, and why is the public criticism of their use by the so-called reformers so openly ignored?

Another point emphasized by the same reviewer, whose words apparently bore too much of "authority" to influence the author of the book criticized, was the abundance of "perfect and confessed synonyms" in the *Catalogue*, thus swelling its bulk, but decreasing by inverse proportion the confidence we can feel in it as the product of careful work. Several cases were cited (*Silene Cucubalus* and *S. vulgaris*, for example); but, as we have now learned to expect, the same misleading and unjustified duplication of names occurs in the new edition. When, however, the same species appears under different genera, as in case of *Aster nemoralis* Ait., we must confess the least bit of surprise. Professor Greene, in splitting the genus *Aster*, revived for part of it the Nuttallian genius *Eucephalus*. Among other species which

[17] GREENE, E. L.: Pittonia 3: 129.

[18] ROBINSON, B. L.: Am. Nat. 32: 460.

he proposed was *Eucephalus nemoralis*, based upon *Aster nemoralis* Ait., though in *Aster* he left the closely related and often indistinguishable *A. acuminatus* Michx. In the new *Catalogue* we find under *Aster*, *A. nemoralis* Ait., listed and numbered, while under *Eucephalus* we have *E. nemoralis* Greene, treated in the same handsome manner. The troublesome *Aster nemoralis* var. *Blakei* Porter, however, a plant which so mingles the characters of *Eucephalus nemoralis* Greene and *Aster acuminatus* Michx. as to embarrass even its own author, is wisely left with *Aster nemoralis*. Why, then, if *Eucephalus nemoralis* is identical with *Aster nemoralis*, does the author of the *Catalogue* list the variety of the latter only under *Aster*, when the species is treated as belonging to both genera?

Many of us were brought up to speak of *Alisma Plantago* L. and *Veronica Anagallis* L., but during the past decade the followers of the Rochester Code have adopted the fad of calling these plants *Alisma Plantago-aquatica* and *Veronica Anagallis-aquatica*. The use of such names has indeed afforded an interesting diversion and has kept us constantly tingling with expectant excitement as we have waited to see what other familiar names would appear in new and fantastic garb; but it must be confessed that a careful search in the volumes of *Species Plantarum*, where these names are said to occur, has failed to reveal them. Instead this is what is found: *Veronica Anagall.* ∇ and *Alisma Plantago* ∆. Thus it seems that Linnaeus did not write even *Anagallis* in full; and we should like to be informed on what authority (in the *Species Plantarum*) we know that ∆ and ∇ are both mysterious ways of writing *aquatica?* And if a triangle is said to mean *aquatica* why do not the reformers append that adjective to their *Roripa Nasturtium*, for Linnaeus wrote *Sisymbrium Nasturtium;* or does the position of the triangle in relation to the name $\overset{\nabla:m}{\text{name}}$ give it a new meaning? Here is a great opportunity for someone to hunt up all the triangles in the *Species Plantarum* and thus give us a new lot of specific names. But, seriously, we may ask why, in the new edition of the *Catalogue* (as in the old), this modern fad was followed?

The triangles, like some other symbols occasionally used by Linnaeus, presumably descended from earlier authors, and if they are taken to mean *aquatica*, and that adjective is written as a portion of the plantname, we are simply reverting to the pre-Linnaean method of polynomial (or at least trinomial) names, and the whole system of binomials is weakened. The date 1753 has been generally accepted as the limit back of which we are not to go for names; and if Linnaeus himself did not use the name *Alisma Plantago-aquatica* or *Veronica Anagallis-aquatica*, are we justified in going back to some earlier author for such names? Right here is a very dangerous tendency in the usage of the reformers. If they will thus admit an occasional pre-Linnaean name which was not used in the first edition of the *Species Plantarum*, what assurance do they give us that their strict priority rule with a time-limit definitely set at 1753 may not at any time be made elastic enough to protect any whimsical exception its advocates choose to set up?

One of the members of the *Check List* Committee, speaking of the citation of the original author of a combination, has informed us that "it is no longer a question of credit, but a question of practical utility."[19] Surely this is the ideal for botanical nomenclature which every serious student will commend; and we may well put to ourselves the question, is "practical utility" in view or does it seem very near actual attainment, when we find the members of the committee which set out to give us a uniform system of names "at war with" their own rules? Has the "day of 'law'" really begun when those with whom a great trust has been placed juggle with it as with a toy, now following this principle, now that, and ignoring at their own wills such candid criticisms of their methods as show the inconsistencies in their work? Is the "day of 'authority' as such" indeed ended when, after one of their own associates on the committee has publicly reprimanded them and has pointed out the only course for one who would live up to the principles he has espoused, the supporters of the Rochester Code continue to

[19] WARD, L. F.: Bull. Torr. Bot. Club **22**: 325.

employ names inconsistent with the principles there emphasized?

A member of the committee already quoted has said, in defending the principles of the Rochester Code (principles which as abstract principles need little defense), "if matters are to be left to the individual judgment of publishing botanists, there will be no comparing the confusion that is in store for us with that which we have had in the past."[20] Where in the past (as embodied in the recent editions of Gray's *Manual*, the book selected by this author for his comparisons and generalizations), will he find 25 per cent. of the names changed, as has occurred within four years in the case of our ferns, and that after the names were said to be established on strict priority principles?

The same author in speaking of the Rochester Code has written further: "Those who oppose this movement, if there be any (and I have no doubt there are) who *really see that it might be the last time* that serious changes would have to be made in botanical names, would seem to do so purely from a personal disinclination to incur the annoyance of accustoming themselves to a new set of names. It must be admitted that *this motive is not as high as we might hope botanists generally to be actuated by* [italics ours]."[21] An associate of this writer on the committee has expressed "the hope that Dr. Robinson and the few who think with him on this subject will *lay aside personal prejudices and join the remaining nine tenths of our botanists* . . . . in a nomenclature based on scientific needs and a scientific method [italics ours]."[22] Both of these authors wrote in 1895, when the *Check List* was a comparatively new topic for discussion. Can it be that now, in view of the facts here presented, they still believe that the *Check List* really represented "the last time that serious changes would have to be made in botanical names," or that the loose and undiscriminating methods employed by many who are now active exponents of the Rochester Code are bringing us any nearer that "last time?"

[20] WARD, L. F.: *ibid.*, 316.

[21] WARD, L. F.: *ibid.*, 319.

[22] COVILLE, F. V.: BOT. GAZ., **20**: 167.

In formulating a system of nomenclature we should keep constantly in view the "question of practical utility." If this fundamental point is neglected, what woeful confusion must be encountered by everyone who attempts to use plant names! Already matters have reached such a state, that few followers of the Rochester Code can say offhand what many common plants should be called. The well-known species described by Ventenat as *Dalea purpurea*, then by Michaux as *Petalostemum violaceum*, but generally known of late as *Petalostemon violaceus*, has been treated as follows during the past decade. Otto Kuntze, in his *Revisio Generum Plantarum*, called it *Kuhniastera violacea*, ascribing the name to Aiton, who, however, wrote *Kuhnistera violacea*. This latter name is taken up by Kellerman and Werner who ascribe it to Otto Kuntze although (according to Steudel's *Nomenclator*, ed. 2, 1:851, a well-known work) the name originated with Aiton. In the *Metaspermae of the Minnesota Valley* the plant is called *Kuhnistera purpurea* (Vent.) MacMillan; but it has recently been published as *Petalostemon purpureum* (Vent.) Rydberg, and in Mr. Heller's new *Catalogue* it is listed essentially under this name (as *P. purpureus*). After these Jekyll-and-Hyde-like changes it is certainly reassuring to see Dr. Jekyll getting the upper hand, and to find in the latest writings of some of the reformers the long established name *Petalostemum* (*on*) reappearing. But do these names used by various reformers represent uniformity? Even if an occasional systematic botanist can keep track of the changes in names, how about the morphologist, the histologist, the physiologist, the pathologist, the paleontologist, the ecologist, to say nothing of the horticulturist, the pharmacist, and the everyday student of plants? Should not all these followers of pure or applied botany be considered in our interpretation of the "question of practical utility?" And what can they hope for in a system of names which shows no more stability than the one under discussion?

To the student whose work is in other fields than systematic botany, the present lack of uniformity in plant names is necessarily most perplexing. But to the systematist, who sees more

closely the constant haggling over names, the situation is quite as puzzling. The Rochester Code was formulated ostensibly to establish uniformity in our names. Its followers have worked vigorously to comply with its rulings. From time to time their attention has been publicly called to fundamentally weak spots in its wording. Again they have been asked to explain certain of their names seemingly inconsistent with their principles. Yet these criticisms have generally been ignored. Instead of strengthening the weak spots in their rules and correcting self-evident mistakes in their names, the reformers have faithfully clung to the discredited gods they had already set up. These statements are not extravagant nor vague generalizations. They are simple conclusions drawn from the facts presented in this discussion, and from others very apparent upon many recent pages. Is this the best the Rochester Code can do? Is this what we are to call "uniformity?"

If we are really desirous of obtaining stability in our nomenclature, and if at the same time the "question of practical utility" is to be considered, our clearest course cannot be by the Rochester Code, especially as followed by its originators. We shall, however, find a comparatively clear and practical method by adopting in our selection of generic names the Berlin rule; and in our selection of specific names, the so-called Kew rule of retaining the first specific name used under the accepted genus. In this way we are able to retain a very large proportion of the long-established and best-known combinations, without the necessity of wading (often blindly) through the mazes of obscure and poorly indexed literature. And, what is better, after comparatively slight alteration of the long-established names, we can feel that in only very rare cases must we abandon those known to practically all botanists. If, like Professor Ward, we all feel that "it is no longer a question of credit, but a question of practical utility," is not this simpler course worth testing?

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BRIEFER ARTICLES.

OBSERVATIONS UPON THE FEEDING PLASMODIA OF FULIGO SEPTICA.

(WITH ONE FIGURE)

ALTHOUGH considerable attention has been paid to the plasmodia of the Mycetozoa, especially by the German botanists (De Bary, Zopf, Sachs), little work has been done upon the feeding habits of these interesting protoplasmic masses. In a valuable contribution to the life history of these organisms, Lister[1] sets forth in a painstaking way the manner in which the plasmodium of *Badhamia utricularis* behaves when actively feeding. Various substances were tried by way of experiment. Pieces of *Agaricus campestris*, *A. melleus*, *A. rubescens*, *A. fasciculares*, *Boletus flavus*, and *Corticium puteanum* were used, but none of these fungi seemed so desirable a food as *Stereum hirsutum*, which was devoured without leaving any residue. *Agaricus fasciculares* was found in these experiments to be a particularly unwholesome morsel. The digestion by the active plasmodium of the fungi above mentioned presupposes the presence of a nitrogenous ferment, namely a proteohydrolytic one. As far as Lister's observations show, starch seems to be refused by the moving plasmodium, contradicting the idea of the presence of a diastatic ferment. The following observations upon the plasmodium of *Fuligo septica* is in part a contribution to the life history of plasmodia in general.

While searching for Mycetozoa in the wooded valley incorporated as part of Woodlands cemetery, West Philadelphia, a luxuriant growth of *Pleurotus sapidus* was found upon some partially decayed logs, which had been piled up in a loose manner preparatory to burning. In removing several large pieces of this fungus, small patches of yellow plasmodium were found upon the lamellar surface of the fully expanded pilei. These protoplasmic masses had moved out from the rotten log where they were seen in the crevices, and had invaded the gill surface

[1] Notes on the plasmodium of *Badhamia utricularis* and *Brefeldia maxima*. Ann. Bot. **2**: 1–23. 1888.

of *Pleurotus sapidus*. The appearance of the larger plasmodium at this time may be described as follows: The gills which were still rigid and in natural position were connected in the invaded portions of the lamellar surface by bridges of slimy yellow protoplasm. The basidial layers were covered by the more delicate portions of the plasmodial reticulum. The larger, more cord-like streams of protoplasm stretched from gill to gill, connecting as main cables the outlying pseudopodial fingers of protoplasm. The plasmodia growing upon several separate pieces of fungus were removed at 2 P. M. Friday, November 2, carried to the botanical laboratory of the University of Pennsylvania, and covered by two bell jars provided with dampened filter paper. By 6 P. M. of the same day the larger plasmodium had increased to such an extent as to cover completely the fungal pieces under one of the bell jars, and the gills showed signs of collapse. At 9 A. M., Saturday, November 3, the gills were found to be in a total state of collapse, Fuligo by this time having taken complete possession. Under the other bell jar the plasmodium, which was originally about the size of a silver dollar in superficial extent, had increased until it had spread to the outer circumferential margin of the lamellar area. In their attack upon the edible portions of Pleurotus, masses of protoplasm heaped themselves up into rounded knobs, or protuberances formed by condensations of the myxomycete substance. These would disappear, to be finally replaced by others of similar size and form. These observations were made on Saturday morning. The invasion and destruction of the gill surface was complete by Monday.

An examination of the growth under the bell jars showed a most remarkable development of the larger plasmodium. It not only covered the fungus, but also the inner sides of the bell jar in the form of a beautiful yellow reticulum. The wet filter paper plastered upon the top of the bell jar was completely covered by a dense mass of anastomosing protoplasm. Upon the main currents of plasmodial movement were beads of protoplasm of larger and smaller size. Where these hung, as pendent drops on the moist filter paper, they had grown until the protoplasm hung, as yellow stalactites, dangling from the dome-like roof of the inner side of the bell jar. The dome of the bell jar on Monday was almost entirely covered by the yellow plasmodium.

A strip of filter paper with the actively streaming plasmodium of Fuligo was removed from the moist chamber and placed in a dry situation in the bright sunlight. As the filter paper dried, the protoplasm

rapidly streamed to the wettest portion, and then began to aggregate into an extended aethalium. The drying, however, took place so rapidly that the entire plasmodium had not time to withdraw itself from the filter paper, and therefore it dried *in situ*, leaving a characteristic network of dry anastomosing threads. The reproduced photograph was taken by Mr. W. H. Walmsley just before the moving plasmodium was placed in the sunlight.

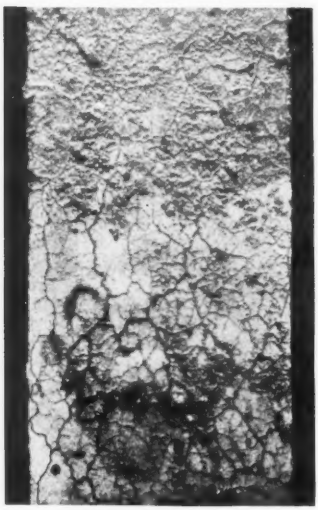

FIG. 1.—Moving plasmodium of *Fuligo septica* on moist filter paper, showing the varicose condition of the recticulum while actively streaming.

Beneath the bell jars, as the disintegration of the fungi proceeded with the production of a watery fluid and a gelatinous substance of a ropy consistency, the more active protoplasmic masses confined themselves to the tougher portions (the stipe and main substance of the pileus), heaping up on these portions in the concentrated effort to digest them. With the drying of the interior of the bell jars, condensation of the reticulum took place, so that the meshes became smaller and the anastomosing streams more closely aggregated. At this stage of growth experiments were begun by feeding Fuligo various substances.

At 1 : 30 P.M. Tuesday, November 6, pieces of fresh young Pleurotus were placed upon the living plasmodium. At 2 : 15 P.M. the small pieces used were invaded and the plasmodium had spread over about half of the superficial surface of the fungal food. Pieces of young pilei of *Coprinus comatus* were placed on different spots of the same plasmodium, and by 2 : 15 P.M. invasion had well advanced, but the rapidity of forward movement was much less when Pleurotus was used as a food. Two hours after the two food substances had been placed within reach of the streaming protoplasm, complete covering of the specimens had occurred.

Pieces of a partially dried toadstool, *Hypholoma perplexum*, were also

placed within contact of another plasmodium of Fuligo at 1 : 30 P.M., November 6, but at five o'clock not a single pseudopodial branch of the plasmodium had moved up upon them. On the contrary, when at four o'clock several pieces of the pileus and stem of *Coprinus atramentarius* were laid upon the yellow protoplasmic mass, inside of three quarters of an hour the trophotropic action of the food substance began to manifest itself by the plasmodial invasion of the newly provided nitrogenous food substance. The incorporation of the nutritive matter had well proceeded up over the edges of the young pilei of *Coprinus atramentarius* by five o'clock, November 6. An examination on the morning of November 7 showed the inky Coprinus almost entirely digested, and a black mass of spores in a gelatinous matrix indicated a total collapse of the fungus. *Hypholoma perplexum* was also covered by a network of the mycelium, which had spread not only over the stipe, but also over the gills and upper surface of the pileus. By evening, this agaric had collapsed, and by the next morning, November 8, nothing remained but a soft gelatinous mass of substance.

Raw beefsteak was applied to the surface of the plasmodium at 11 : 30 A.M., November 7, and by noon a single strand of protoplasm had advanced upon the meat. At 1 : 30 P.M. one third of the surface of the meat, and by 5 : 00 P.M. the entire surface, was covered. Digestion must have been rapid during the night, because upon returning to the laboratory in the morning of November 8 not a trace of the beefsteak was to be found.

Pieces of the gleba and stipe of *Phallus impudicus* were also applied at the same time. During the afternoon of Wednesday, November 7, the pieces of gleba were well covered by the moving plasmodium, the stipe portions being left untouched. By the next morning the glebal pieces had almost entirely disappeared, and cuts from the stipe still remained untouched.

Beefsteak was again supplied to the plasmodium at 10 : 00 A.M., Thursday, November 8, and by 10 : 45 A.M. a few arms of the plasmodium had extended themselves over the free edges of the meat.

The purpose was next to extend the series of observations by feeding to the active plasmodium a variety of nitrogenous and fatty materials. Cheese, boiled white of egg, boiled yolk of egg, and butter were chosen. Pieces of these substances were applied to the surface of the reticulum on Thursday morning, November 8. The plasmodium seemed at first to refuse them, but by Friday morning the fragments

of boiled white of egg were found to be partially covered by the creeping Fuligo. On Saturday morning, November 10, the hardened, coagulated egg albumen was completely covered and well-nigh digested. The yolk was but slightly affected by the plasmodium, even after exposure to the digestive action for two whole days. The butter was left untouched.

The presence of several ferments is naturally inferred from the digestive action accomplished by the plasmodium. According to De Bary, diastase can be extracted from the plasmodium of Æthalium (Fuligo).[2]

In his book on ferments Green[3] states: "One of the earliest known of these is the ferment which Krukenberg found to be procurable from the plasmodium of Æthalium, one of the Myxomycetes. A glycerine extract of the plasmodium was found to have very marked proteolytic powers in the presence of lactic or hydrochloric acid. Krukenberg's statement has been confirmed by Miss Greenwood, who has stated that the plasmodium of another member of the same group yielded to 0.4 per cent. hydrochloric acid an extract which showed marked solvent action on fibrin." Negative results were obtained when I removed some of the partially digested fungus with plasmodium upon it, and treated the mass with glycerine, according to the directions given above. To the glycerine extract, which had a slightly yellowish color, a few drops of 35 per cent. hydrochloric acid was added, and a small frayed piece of raw beefsteak. After two days of trial the beefsteak was found unchanged, although left in the glycerine extract for that length of time.

The plasmodium brought into the laboratory on Friday, November 2, was still in a streaming condition on Saturday, November 10, when observation upon it ceased. The original fungus, with the exception of the more fibrous stipe, had in this time been reduced to a fibrous gelatinous mass, upon which the plasmodium still streamed, finding apparently enough remaining food to feed upon, although by this time the common mold had invaded it. This mold appeared for the first time on Wednesday, November 7, but was then brushed off to prevent fruiting. The plasmodium, while actively streaming and feeding, kept the substratum remarkably sweet and clean, and it was not until the original food substance had been destroyed as food that foreign organisms, such as the mold, had any chance for development. This

[2] This statement is somewhat at variance with the observations of Lister, *loc. cit.*

[3] The soluble ferments and fermentation 215. 1899.

was certainly one of the most instructive facts brought out during the course of my observations.[4]—JOHN W. HARSHBERGER, *University of Pennsylvania.*

SWARM SPORE FORMATION IN HYDRODICTYON UTRICULATUM ROTH.[5]

1. The methods of fixing were by means of Merkel's fluid and a mixture of iridium chlorid and acetic acid according to one of the following formulae:

(1) Eisen. Iridium chlorid (0.5 per cent. aqueous solution) - - 100cc
Glacial acetic acid - - - - - - - 1cc
(2) Iridium chlorid (1 per cent. aqueous solution) - - - 100cc
Glacial acetic acid - - - - - - - 3cc

The best results were obtained with the stronger iridium chlorid mixture.

2. There is no differentiated chromatophore in the cell. The pyrenoids and nuclei are scattered irregularly throughout the cytoplasm and the chlorophyll is contained in the whole cytoplasmic body. The nuclei in both the resting and dividing stages show the structure typical of higher plants and are not to be taken as types of primitive nuclei.

3. Cleavage takes place by means of surface constriction of the plasma membrane on the outside and the vacuolar membrane on the inside of the protoplasmic layer. The process is a progressive one, the cleavage furrows cutting out first large irregular multinucleated masses of protoplasm, which are in turn divided into smaller masses, until each contains a single nucleus, the entire protoplast thus being divided into spores. The swarm spores are uninucleated biciliated cells. At the base of the pair of cilia there is a clearly defined basal body.

A detailed description of the processes outlined above will be published soon in a more complete form.—H. G. TIMBERLAKE, *University of Wisconsin.*

[4] One of the best methods of procuring material for microscopic study is to remove the protoplasm by scraping, and then to place portions of it on slides fitted into the bottom of Petri dishes provided with moist filter paper. In an hour or two these mounds of protoplasm will have spread out over the slides sufficiently to permit of their examination. At my suggestion, Dr. Mazijck Ravenel, bacteriologist of the Pennsylvania Live Stock Sanitary Board, tried to grow the plasmodium upon ordinary agar, and upon filter paper saturated with bouillon, but failure resulted in both cases.

[5] Résumé of results presented at the meeting of the Western Naturalists at the Hull Botanical Laboratory, December 27, 1900.

CURRENT LITERATURE.

BOOK REVIEWS.

Goebel's Organography.[1]

THE second volume of this notable work has appeared recently. It deals with the gametophyte and sporophyte of pteridophytes, and with the sporophyte of spermatophytes. The gametophyte of the pteridophytes is discussed under two heads, namely, (1) structure and development of the sex organs, and (2) the form of the prothallia. In discussing the development of antheridia the author advances views which are at variance not only with those of Belajeff and others, but also with his own previous accounts. In Isoetes, after the cutting off of the small cell which Belajeff has called the rhizoidal cell, two oblique walls divide the main body of the spore into two flat cells and a larger cell which is triangular in optical section. This last cell alone the author regards as the antheridium initial. It divides by a periclinal wall into an outer cover cell, and an inner cell, the latter of which by further division gives rise to four cells in each of which a spermatozoid is organized. According to this interpretation there is within the spore wall a prothallium consisting of three sterile cells and one antheridium, and only the cover cell can be regarded as belonging to the antheridium wall.

In presenting the development of both the antheridia and the archegonia the transition from free to imbedded organs is described in some detail. The prothallia of Ophioglossum, Botrychium, and Lycopodium receive particular attention on account of their biological importance. The vegetative multiplication of prothallia is another interesting subject which is somewhat fully treated.

In the second part of the book, which is devoted to the sporophyte of pteridophytes and spermatophytes, the various organs are discussed in great detail. The account of the embryo is particularly helpful. Among other interesting subjects are the transition between leaf and shoot, leaf formation the relation between venation and leaf devolopment, transformed leaves, branching, etc.

The treatment throughout is dominated by what may be called experimental morphology, and the book cannot fail to have a good influence in

[1] GOEBEL, K.: Organographie der Pflanzen insbesondere der Archegoniaten und Samenpflanzen. Zweiter Teil. Specielle Organographie. 2 Heft: Pteridophyten und Samenpflanzen. Erster Teil. 8vo., pp. xiii–xvi + 385–648. 173 illustrations. Jena: Gustav Fischer. 1900. *M* 7.

relaxing the too rigid notions of morphology which are still prevalent. While constantly calling attention to the variation which occurs in nature and which may also be brought about artificially, the author also recognizes that environment is not the only factor in plant development, but that heredity is equally important. Representing as it does the work which is being carried on in the author's laboratory, the book has the freshness of research, and is full of suggestions to those engaged in morphological investigation.

Those who have read the first part will be glad to learn that the present volume is not so difficult. An early English translation is announced.—CHARLES J. CHAMBERLAIN.

MINOR NOTICES.

THE SIXTH FASCICLE of Wildeman and Durand's *Illustrations de la flore du Congo* has appeared recently, containing plates 61 to 72 inclusive. This elaborate work, with its very handsome plates, needs no further commendation than has been given already in this journal.—J. M. C.

THE SECOND FASCICLE of Schumann's *Blühende Kakteen* (Iconographia Cactacearum) has appeared recently. It contains descriptions and beautiful colored illustrations of *Mamillaria Wissmannii* Hildmann, *M. raphidacantha* Lem., *Echinocactus horripilus* Lem., and *E. Mathssonii* Berge. The publisher is J. Neumann in Neudamm, and the price is four marks.—J. M. C.

THE SECOND VOLUME of *Primitiae Florae Costaricensis*, under the editorship of H. Pittier, bearing date 1898–1900, has appeared in seven fascicles. The collaborators are J. Donnell Smith (Polypetalae and Gamopetalae), Casimir DeCandolle (Piperaceae), G. Lindau (Acanthaceae), F. Pax (Euphorbiaceae), and A. Engler (Araceae). Numerous new species are described, but the only new genus published is *Kolobohilus* (Acanthaceae).—J. M. C.

THREE FASCICLES of the first volume of Engler and Prantl's *Nat. Pflanzenfamilien* have appeared recently, as follows: 204 contains the conclusion of fossil Filicales and the Sphenophyllales by H. Potonié, and the beginning of the living Equisetales by R. Sadebeck; 205 contains the conclusion of the living Equisetales by R. Sadebeck, the fossil forms by H. Potonié, and the beginning of the Lycopodiaceae by E. Pritzel; 206 contains the conclusion of the Lycopodiaceae and the Psilotaceae by E. Pritzel, the Psilotaceae by H. Potonié, and the beginning of Selaginellaceae by G. Hieronymus.—J. M. C.

A. M. FERGUSON (Twelfth Ann. Rep. Mo. Bot. Gard. 33–73. *pls. 4–31.* 16 F 1901) has published a revision of the species of *Croton* found in the United States. It seems to be a painstaking and judicious piece of work, and deals with a genus which greatly needed revision. Thirty-three species and varieties are recognized, all of which are illustrated. The conservative spirit of the work is indicated by the fact that in a genus of great possibilities only one new species is described, and five forms are made new varieties.

It is certainly true that the author's conception of a species differs from that which is rapidly becoming current, and that he still has some belief in its power to vary.—J. M. C.

MR. HERMANN VON SCHRENK (Twelfth Ann. Rep. Mo. Bot. Gard. 21–23. *pls. 1–3.* 10 F 1901) has described fully a disease of *Robinia Pseudacacia* L. caused by *Polyporus rimosus* Berk. The fungus attacks the locust after some heartwood has been formed in the larger branches, and from this time on the mycelium may be found in the heartwood. Access is obtained through wounds, so that a proper treatment of wounds will ward off the disease. Curiously enough the fungus, although growing in what is regarded as dead tissues, does not grow in the wood after it is cut from the living tree, and hence diseased wood when used for posts does not continue to rot. Whether such a fungus is to be regarded as a parasite or a saprophyte, therefore, becomes an interesting question.—J. M. C.

THE FIRST THREE PARTS of Engler's *Pflanzenreich* have appeared. The general purpose and method of this great work were announced in this journal for last December (**30**: 432. 1900), so that it only remains to note the contents of the parts as they appear. The families of spermatophytes to be presented are 280 in number. Part 1 (*M* 2.40) is by K. Schumann, and contains the Musaceae, the forty-fifth family, the six genera including eighty species. Part 2 (*M* 2) contains the eighth and tenth families, Typhaceae and Sparganiaceae, and is by P. Graebner. Each family is represented by a single genus, Typha containing nine species and Sparganium fifteen. Part 3 (*M* 5.60) contains the ninth family, Pandanaceae, and is by O. Warburg. He recognizes 219 species, 156 of which belongs to Pandanus. The publisher is Wilhelm Engelmann of Leipzig.—J. M. C.

BOTANICAL ACTIVITY in Vermont is indicated by the series of "Contributions to the Botany of Vermont," which has now reached its eighth number. The titles of the eight contributions are as follows: A list of the mosses of Vermont, with analytical keys to the genera and species, by A. J. GROUT (March 15, 1898); A partial list of the parasitic fungi of Vermont, by W. A. ORTON (September 1898); A preliminary list of the Hepaticae of Vermont, by CLIFTON D. HOWE (January 1899); Supplement to the list of mosses growing in the state of Vermont, by A. J. GROUT (January 1899); The trees of Vermont, by ANNA M. CLARK, with notes on the trees of Burlington and vicinity, by L. R. JONES (December 1899); A second partial list of the parasitic fungi of Vermont, by W. A. ORTON (December 1899); and Flora of Vermont, a list of the fern and seed plants growing without cultivation, by EZRA BRAINERD, L. R. JONES, and W. W. EGGLESTON (December 15, 1900). The last publication enumerates 1330 indigenous species.—J. M. C.

A FLORA of the German possessions (Kaiser Wilhelm's Land) in New Guinea (or Papua) and the adjacent islands has been published by Drs. Karl

Schumann and Karl Lauterbach.[2] Descriptions are given of numerous new and critical species, but those better known are merely named and their distribution given. The book begins with the Myxomycetes and follows the sequence of Engler and Prantl. This bringing together of a great amount of scattered material makes the book an admirable compendium of information concerning the plants of the "South Seas." The new genera described are as follows: *Dammera* (Palmaceae), *Sclerometum* (Santalaceae), *Lauterbachia* (Monimiaceae), *Macropsychanthus* (Leguminosae), *Syndyophyllum* (Euphorbiaceae), *Gertrudia* (Flacourtiaceae), *Xenodendron* (Sonneratiaceae), *Bamlera* (Melastomaceae), *Kentrochrosia* (Apocynaceae), and *Airosperma* (Rubiaceae).—J. M. C.

A VALUABLE CONTRIBUTION to the literature of special diseases of plants is the recent bulletin of the Division of Vegetable Physiology and Pathology on *Peach leaf curl*.[3] The bulletin is divided into eleven chapters. The first is introductory and treats of the distribution and origin of the disease and of the losses caused by it, which are estimated to reach at least $3,000,000 annually. Next is taken up the nature of the disease itself, which is caused by the fungus *Exoascus deformans*. It is shown that the perennial mycelium of this fungus is responsible for only about 2 per cent. of the infections each spring, the others being due to spores which have remained over winter in the crevices of the bark and between the bud scales. In the next five chapters the history of the various methods of treatment is discussed, and the plans of the experiments for the prevention of the disease and the results in saving of foliage and fruit are given in great detail. It is shown that from 95 to 98 per cent. of the injury to the foliage can be prevented by treating the trees, while still dormant, with various sprays, the best being a Bordeaux mixture containing five pounds each of copper sulfate and lime, and forty-five gallons of water. One chapter is devoted to a discussion of the preparation, use, and character of the different sprays used, another to the methods of applying the sprays, and still another to a description of the various substances used in preparing them. The sprays are shown to be successful only when applied while the tree is dormant, preferably one to three weeks before the flower buds open. The final chapter is devoted to a comparison of the susceptibility of different peach varieties to the disease, and to a discussion of the treatment of nursery stock. A short summary concludes the bulletin.—ERNST A. BESSEY.

[2] Die Flora der deutschen Schutzgebiete in der Südsee. Small 4to, pp. xvi + 613. with map and 22 plates. Leipzig: Gebrüder Borntraeger. 1901. *M* 40 unbound, *M* 45 bound.

[3] PIERCE, NEWTON B.: Peach leaf curl: its nature and treatment. Bulletin 20. Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, 8vo, pp. 204. *figs. 10, pls. 30* Washington: Government Printing Office. 1900.

NOTES FOR STUDENTS.

EBERHARDT[4] has performed a series of experiments with a view to finding the influence of dry and humid air on plant structures. These experiments in general confirm the work of Kohl and others. Humid air causes an increase in the length of the stem and the size of the leaf surface, while there is a decrease in the stem diameter, the amount of chlorophyll, and the root development. Dry air increases the thickness of the cuticle, the number of stomata, the woody tissue, the sclerenchyma, and the palisades.— H. C. COWLES.

SOME INTERESTING STUDIES have been made by Nestler[5] upon the well-known glandular hairs of *Primula obconica*. Physicians and gardeners have often asserted that this common primrose is poisonous, and Nestler has succeeded, not only in proving these statements, but also in localizing the poison. The glandular hairs contain the poison in the form of a yellowish green secretion; this when concentrated is very virulent, as the author discovered by testing the effect upon himself. The hairs of *Primula Sinensis* act in a similar way, but the poisonous effects are much less marked.—H. C. COWLES.

DR. G. KLEBS published last year[6] the third paper of a series on the physiology of reproduction in fungi in which he brings together the previous investigations with some hitherto unpublished researches, and seeks to present general considerations on the whole subject. The paper is full of suggestions and too valuable to mutilate by an attempt to summarize it. One general criticism lies against Klebs' work and his conclusions, namely, that he does not take into account sufficiently the effect of changes in osmotic pressure to which his experimental plants are subjected with the changing composition. It remains to be seen whether the conclusions are not vitiated by this untested factor.—C. R. B.

KEARNEY[7] discusses the Lower Austral element in the southern Appalachians. The mountains have representatives from all of Merriam's zones from the Lower Austral to the Hudsonian, though the Transition zone is most fully represented. Austro riparian colonies are found up to 1200 feet along the eastern boundary of Tennessee. Kearney divides the Austral mountain plants into those which are probably of neotropical origin and have come in since the ice age, and those which have probably descended from the Tertiary floras of northern regions. The plants of the first group are chiefly xerophytic, while those of the second group are mainly ligneous tropophytes. Lower Austral forms must have left the mountains during the

[4] Compt. Rend. **131**: 193–196, 513–515. 1900.

[5] Ber. deut. bot. Gesell. **18**: 189–202, 327–331. 1900.

[6] Jahrb. f. Wiss. Bot. **35**: 80–203. 1900.

[7] Science N. S. **12**: 830–842. 1900.

glacial period. Interesting hypotheses are given on the origin of the Austral forms.—H. C. COWLES.

MLLE. RODRIGUE[8] has made a painstaking study of the anatomy of variegated leaves with a view to ascertaining the relation between color and structure. The author gives an excellent summary of the literature of her subject, and makes a detailed study of thirty-three species. The white effect is due in most cases to the absence of chlorophyll, although a similar appearance is given by certain dissolved pigments, and by the reflection of light in some special instances. The modifications in the latter cases are slight and are confined to the epidermis. Where chlorophyll is absent, the leaf may be regarded as diseased, and the tissues are different from normal leaves, having no palisade development, and consequently a great reduction in thickness. In other words, the primitive tissues remain unchanged, where chlorophyll is absent.—H. C. COWLES.

ALB. NILSSON[9] has made some interesting studies on the dynamics of some Swedish plant societies, especially of cliffs and moors. He finds three types of cliffs, those which are forested either with conifers or deciduous trees, and those without trees. On all cliffs the first plants are crustaceous lichens. On the conifer cliffs there follow in succession fruticose lichens, herbs, heath plants, conifers. Cliffs with deciduous trees have no fruticose lichen or heath stages, the author attributing the absence of the fruticose lichens to wind. On the third type of cliff the lichens remain longer and foliose lichens and mosses are added to the stages after crustaceous lichens. Dying lakes pass into sedge moors, then into cotton-grass moors, finally into shrub moors and forest moors with pines or birches. Retrogressive phases are common on the moors, lichens growing over the peat moss and shrubs; again the water collects and the lichens pass away. The peat moss appears again and we have what Nilsson calls a secondary moor.—H. C. COWLES.

THE STYLIDIACEAE (Candolleaceae in Engler and Prantl's *Nat. Pflanzenfam*), a small family almost confined to Australia, New Zealand, and farther India, has been recently studied by G. P. Burns.[10] The greater part of the paper is devoted to a morphological study of the various tissues. Before fertilization the structures of the embryo sac present no unusual features, but immediately after the entrance of the pollen tube the micropylar portion of the sac grows out into an enormous haustorium much larger than the remainder of the sac. The endosperm forms rapidly and fills the sac with tissue before the first division of the ogg takes place. Shortly after fertilization the antipodals disintegrate, and the posterior portion of the sac also

[8] Mém. l'Herb Boiss. 17: 1900. [9] Bot. Not. 1899: 89–101; 123–135.

[10] Beiträge zur Kentniss der Stylidiaceen. Flora 87: 313–354. *pls. 13, 14* (and 45 text figures). 1900.

forms an haustorium. Finally, the protoplasmic contents of both haustoria become transformed into a network of cellulose threads which in case of the upper haustorium form a plug effectually closing the micropyle. The sac is surrounded by a jacket or "tapetum" which is even more conspicuous than in the Compositae.—CHARLES J. CHAMBERLAIN.

THE FUNCTION of latex, so often in past years a motive for investigation, has again been made a subject for study. Gaucher[11] gives a historical summary of the two chief views, excretory and nutritive, from the time of Trécul to the present. The author gives no new theories, but presents a large number of facts which favor the nutritional function, very much as presented by Haberlandt. The substances contained in latex, the connection between the latex tubes and the palisade, and the reciprocal relations between latex tubes and conductive parenchyma are all studied, and Gaucher in these cases confirms and extends Haberlandt's observations. In one instance he finds a ring or festoon of chlorophyll cells arranged about a latex tube.

Parkin[12] has studied the latex in rubber plants of Ceylon, and holds a somewhat intermediate view. While he regards the proteids of latex as probably nutritive, he does not so regard the starch, unless perhaps the latter aids in the nutrition of the latex tubes themselves. The author finds that the latex flows far less abundantly at the first tapping than subsequently, showing an apparent adaptation. Parkin regards the chief function of latex to be water storage.—H. C. COWLES.

SOME VALUABLE CONTRIBUTIONS to the literature of forest distribution have been made recently by the United States Geological Survey.[13] This report is under the supervision of Henry Gannett, chief of the division, and is a companion volume to a similar one published last year. It contains special considerations of the Pike's peak, Plum creek, and South Platte reserves by John G. Jack; White river plateau timber land reserve by George B. Sudworth; the Flathead forest reserve by H. B. Ayres; and the Bitterroot forest reserve by John B. Leiberg. Topographic features, soil conditions, climate and rainfall, forest conditions, fires, and lumbering are some of the topics treated in these reports. A large number of plates, including both maps and reproductions from photographs, are incorporated in the volume, and a portfolio containing topographic maps showing distribution of timber areas presents the subject in a graphic way.

If the department would but incorporate in its excellent geological and physiographical atlases an additional topographic map showing the distribution of forest and other floral areas, including descriptions of the edaphic and climatic conditions, it would add much to their educational, economic,

[11] Ann. Sci. Nat. Bot. VIII. **12**: 241–260. 1900. [12] Ann. Bot. **14**: 193–214. 1900.

[13] *Twentieth Annual Report, U. S. G. S.*, Part V. Forest reserves, pp. xviii + 498. *pls.* 159. 1898–9.

and scientific value. Some such careful study of a large number of floral areas is an absolute necessity to a correct understanding of the complex climatic and ecologic factors governing the distribution of trees. Indeed, in the last atlas[14] issued by the department an approach has been made to such a realization. This atlas contains a brief summary of the vegetal and climatic features, a map of the floral features, and three maps showing precipitation, evaporation, and types of rainfall.—H. N. WHITFORD.

THE STUDIES of Brenner[15] on succulent plants must prove of great interest to all physiologists and ecologists. His work was experimental and for the most part on the Crassulaceae and Mesembryanthemum. After a discussion of the normal anatomy, he describes the effects produced on succulent plants by moist air. The most striking effect in Sedum is pronounced internodal elongation, which the author refers to the increased turgor incident to lessened transpiration. At first the leaves are fleshy, but later leaves are larger and thinner and placed like normal fleshy leaves in dry air in the form of a rosette. There is thus a striking correlation between stem elongation and leaf form. Another effect of moist air on the leaves is epinasty, so that the new leaves place themselves at right angles to the stem; when these plants are placed in a dry chamber hyponasty is shown. Notable changes in anatomy are also induced. In two plants the normally straight side walls of the epidermis become wavy, and doubtless give greater mechanical strength to the otherwise weakened leaf. The tangential increase of the epidermal cells as against the radial is very noticeable, though Brenner is at a loss to find a physical explanation therefor. The stomata at first are the same in number as on normal leaves, though of course they are farther apart, since the leaf is larger. On later leaves the stomata are more numerous though the number per unit area may be much as in normal leaves. There is a decrease of the storage tissue and an increase of the chlorophyll tissue, though the cells in the latter tissue are more nearly isodiametric than in dry air. The vascular system and air spaces are decreased in moist air; the reduction in the bundles is rather in number of cells and ramifications than in cell size. The author finds the dry weight and ash and also the acid content to be less than in normal plants. At first moist air increases the size of the chloroplasts, though they decrease in size later, pointing to an apparent readjustment to the new conditions.

Various comparative physiological experiments were made on plants grown in dry and moist air. In Mesembryanthemum nutation movements were noticed in the latter but not in the former. Normal leaves in normal air transpire the same per unit area as do moist-air leaves in moist air, though the leaf form is very different. This observation is very instructive

[14] HILL, ROBERT T.: Topographic atlas of the Texas region, pp. 12. *pls.* 11. 1900.

[15] Flora **87**: 387–439. 1900.

as it shows strong powers of readjustment in such highly specialized forms as succulent plants. The author concludes by saying that the air and not the soil relations are determinative for the above changes. This is in harmony with Kohl's results on Tropaeolum. Brenner thinks that the phenomena which he observed are in a high degree purposeful, and that purely physical explanations are very difficult at many points.—H. C. COWLES.

ITEMS OF TAXONOMIC INTEREST are as follows: ARTHUR MINKS (Mém. Herb. Boiss. 22: 1–74. 1900) has published a full discussion and synopsis of the genus *Umbilicaria*.—WILLIAM R. MAXON (Proc. Biol. Soc. Washingington **13**: 199, 200. 1900) has described a new *Polypodium* (*P. hesperium*), which is "the common form of the whole mountain region of the western United States." The same author (Bull. Torr. Bot. Club **27**: 638. 1900) has described a new *Dryopteris* from Alaska.—P. A. RYDBERG (Bull Torr. Bot. Club **27**: 614–636. 1900), in continuing his "Studies on the Rocky mountain flora," has published an account of some of the smaller genera of Compositae. Those considered are *Stenotus*, formerly a section of Aplopappus, containing seven species, of which two are new; *Stenotopsis*, a new genus established on *Aplopappus* (*Stenotus*) *linearifolius*, and including also *Aplopappus* (*Stenotus*) *interior*; *Macronema*, containing seven species, of which one is new; *Sideranthus*, a genus revived to include species formerly under Aplopappus, and more lately under Eriocarpum, and which is recognized as containing seven species, three of which are new; *Pyrrocoma*, with sixteen species, five of which are new; *Balsamorrhiza*, with nine species, two of which are new; *Thelesperma*, with seven species, two of which are new; *Hymenopappus*, with eight species, four of which are new.—EDWARD L. GREENE (Pittonia **4**: 159–226. 1900) has recently made some important contributions as follows: A fascicle of new forms of *Arnica* contains twenty-four species; Gentianaceae are enriched by three new species of *Gentiana*, three of *Swertia*, and three of *Frasera*; the third of the "Studies in the Cruciferae" discusses certain species of *Arabis*, describing seventeen as new, describes new species in *Cheiranthus*, *Sophia*, *Thelypodium*, *Thysanocarpus*, *Draba*, and *Cardamine* (4 spp.), expresses his conclusion as to the type of the genus *Draba*, and establishes a new genus (*Abdra*) upon what is known as *Draba brachycarpa*; the second of the papers on "Neglected generic types" brings to us *Halerpestes* as a new genus established to include *Ranunculus Cymbalaria* Pursh, *R. salsuginosus* Pallas, and *R. tridentatus* HBK., *Peritoma* DC. to include certain species of Cleome (*serrulata*, *inornata*, *lutea*), *Celome* founded on *Cleome platycarpa* Torr., *Carsonia* founded on *Cleome sparsifolia*, and *Aldenella* founded on *Polanisia tenuifolia* T. & G.; eighteen new species are added to the genus *Aster*, all but one of which are from the Rocky mountains; among the "Corrections in nomenclature" *Oreostemma* is substituted for the untenable *Oreastrum* Greene (containing certain species formerly referred

to Aster), *Nerisyrenia* is substituted for the untenable *Parrasia* Greene (Greggia), and *Eremosemium* is substituted for *Grayia* of the western deserts on account of a prior use of the name. The same author (*idem* 227–241. 1901) has begun the segregation of *Taraxacum* in North America by describing eight new species; and has described new species under *Thalictrum*, *Rumex* (2), *Lappula*, *Allocarya* (2), *Solidago*, *Coleosanthus* (5), *Coreopsis*, *Parthenium*, *Picradenia*, and *Zygadenus* (2).— M. L. FERNALD (Rhodora 2: 230–233. *pl. 21.* 1900) has described two new northeastern species of *Thalictrum*, and two new varieties of *Scirpus maritimus* (*idem* 241. 1900), and has presented (*idem* 3: 13–16. 1901) *Monarda fistulosa* and its allies.— B. L. ROBINSON (Rhodora 2: 235–238. 1900) has discussed and reorganized the nomenclature of the New England representatives of *Agrimonia*, has presented (*idem* 3: 11–13. 1901) the results of his search for the type of the Linnean *Gnaphalium plantaginifolium* which proves to be *A. plantaginea* as interpreted by Fernald, and has discovered (*idem* 16–17. 1901) that *Sisymbrium Niagarense* Fourn. should be transferred as a doubtful synonym under *S. officinale* L. to *Brassica nigra* Koch.— G. E. DAVENPORT (Rhodora 3: 1–2. *pl. 22.* 1901) has described a new plumose variety of *Asplenium ebeneum* from Vermont.— J. M. GREENMAN (Rhodora 3: 3–7. 1901) has set forth the genus *Senecio* as it exists in New England, describing two new varieties of *S. Balsamitae*.— SPENCER LE MOORE (Jour. Bot. 38: 457–469. *pl. 416.* 1900) has described two new genera of Compositae from Africa (*Delamerea* and *Nicolasia*), both belonging to the Inuloideae — A. B. RENDLE (Jour. Bot. 39: 12–22. 1901) has described eleven new species of *Ipomoea* from Africa.— F. LAMSON-SCRIBNER and ELMER D. MERRILL (U. S. Dept. of Agric., Div. of Agrost. Bull. 24: 1–54. 1901) have published new species of *Tripsacum*, *Andropogon* (3), *Paspalum* (2), *Panicum* (3), *Muhlenbergia*, *Agrostis*, *Tristachya*, *Leptochloa*, *Aristida* (2), and *Elymus* (5); and have given the results of a study of the types of *Panicum nitidum*, *P. pubescens*, and *P. scoparium*.— J. M. C.

IN A RECENT PAPER Hans Fitting[16] has given the results of his investigations on the mode of origin of the megaspores, and the development of their coats in Isoetes and Selaginella. His work was done chiefly with living spores examined in a physiological salt solution, and in water. Microtome sections were used to trace the phases of karyokinesis in the spore mother cells, and for a check on the conclusions drawn from the living material.

He agrees with Smith[17] in his account of the origin of the sporangium of Isoetes. It will be remembered that the latter author differed from Goebel, Bower, and Campbell, in asserting that "the rudiment of the sporangium is

[16] Bau und Entwickelungsgeschichte der Makrosporen von Isoetes und Selaginella, etc. Bot. Zeit. 58: 107–164. *pls. 5–6.* 1900.

[17] BOT. GAZ. 29: 225–258, 323–346. *pls. 12–20.* 1900.

a transverse row of superficial cells below the ligule." Also, as regards the formation of the trabeculae and tapetum, Fitting's account is identical with Smith's.

The spore mother cell is distinguished by its finely granular protoplasm, large nucleus, and nucleolus. At one side of the nucleus lies a dense mass of coarse-grained protoplasm, in which are imbedded many small starch grains. Preceding the first division of the mother cell, radiations appear in the protoplasm, extending in all directions to the wall, but from no common center. The mass of mingled protoplasm and starch divides into two nearly equal parts, and new radiations appear between them as they separate. They finally take the positions of two foci of an ellipse, the spore mother cell being nearly of that shape. During this process the nucleus has shifted from the center to the periphery of the cell, and at its conclusion has returned to its original position. The two daughter masses (*Tochter-Klumpen*) elongate and lie in planes at right angles to each other and to the long axis of the cell. The starch grains arrange themselves in straight lines in each mass. Those near the middle slip toward either end and reunite in two groups, surrounded by the dense protoplasm. This process results in four masses of starch surrounded by the coarse granular protoplasm, arranged tetrahedrally. These changes the author followed in living material, observing the spore through the sporangium wall and the several layers of sterile cells, tapetum, etc. The nucleus then divides by two rapid successive divisions, the spindle lying in such fashion that each of the four daughter nuclei lies by one of the *Tochter-Klumpen*. New fibers arise from the surrounding protoplasm and extend themselves between the nuclei, thus forming a sextuple spindle. Equatorial cell-plates cross these spindles, cutting completely through the protoplasm in six planes from the center of the cell to its wall. Partition walls develop in these plates. It is evident that four of these walls have no connection with the spindles concerned in the division of the nucleus.

The origin of the four megaspore membranes is worked out with great detail. The main points are as follows: While the four "special mother" cells are still lying in the form of a tetrad enclosed by the mother cell membrane, each surrounds itself with a separate membrane called the "special mother cell" membrane. The author did not determine whether this was formed by the mother cell membrane or by the protoplasm of the special mother cell. This thickens rapidly and divides into three lamellae which taken together constitute the *exospore*. Between the exospore and the protoplasm of the cell (now called megaspore) developing from the latter, appears the *mesospore*. The outer layer of the exospore becomes roughened with spines or reticulations, and following their exact contour is laid down an incrustation with much silica, which Fitting styles the *perispore*. Some species of

Isoetes lack this coat. All of these membranes grow by intussusception, and the author lays stress on the fact that the perispore and exospore are of quite different chemical nature, and yet are both growing simultaneously by intussusception. Finally, between the mesospore and the protoplasm content appears a thin film of cellulose, the endospore. The nourishment needed for the growth of these membranes is derived from the sporangium wall and trabeculae, not from the tapetal cells. Until the walls are formed the spore content is relatively very small.

The author was less successful in his work in Selaginella. Owing to the smallness of the megaspore and to imperfect technique (he never succeeded in avoiding shrinkage) he failed, like all his predecessors, to make out the stages of the development of the megaspore. The megaspore mother cell is easily recognized, but how it divides into spores is not known.

Heinsen's account and Fitting's disagree in almost every particular as regards the interpretation of the spore contents and the origin of the several coats. The "nucleus" (according to Heinsen) is the entire protoplasmic content. Heinsen's "nucleolus" Fitting interprets as the nucleus. The several small "corpuscles," whose nature Heinsen could not explain, are, according to this author, the nucleoli. The sequence of events as regards the development of the coats is much like that of Isoetes, making an additional reason why Isoetes and Selaginella should not be separated in any system of classification. The author thinks that the extremely small amount of protoplasm in the spore can have nothing to do with the nourishment of the spore coats, which soon far exceed it in thickness and bulk. Between the tapetum and the four megaspores is a sort of slimy matter which Bower interpreted as the remains of the disorganized sterile mother cells. Fitting says that these cells do not disorganize, and that the slime is a secretion from the tapetum, which acts like a gland. This material nourishes the spores up to their maturity, when they fill the entire sporangial cavity. Like those of Isoetes, the spore walls develop by intussusception. A very significant fact is that the greatest growth of the spore walls takes place when they are not in contact with the plasma body within. Four walls are found, exospore, mesospore, endospore, and perispore (the latter sometimes lacking in certain species). The increase in size of the plasma body without corresponding increase in the amount of matter of which it consists, followed by cell division and the formation of the prothallium, were not followed in detail. The author says, however, that in some species this occurs before the spores are shed (*S. Martensii*, *S. Galeottii*), and in others "a long time afterward."—FLORENCE MAY LYON.

NEWS.

ON MARCH 30 the Imperial Zoological-botanical Society of Vienna will celebrate its fiftieth anniversary by a jubilee session in which related academies, societies, associations, and institutes are invited to participate.

A NEW monthly botanical journal, *Torreya*, has been begun by the Torrey Botanical Club of New York City, under the editorship of Marshall A. Howe. The journal is intended for the shorter notes and items which have been lately rather crowded out of the *Bulletin*.

THE YALE SUMMER SCHOOL of Forestry, under the direction of Henry S. Graves and James W. Toumey, will hold its sessions at Grey Towers, the estate of Mr. James W. Pinchot, near Milford, Pa. The school begins July 8, 1901, and continues eight weeks.

IN A RECENT "minor notice" (30 : 418. 1900) in this journal, certain publications being issued by the botanists of Japan were confused. A letter from Professor Y. Yabe makes the following statement: Three series are being issued, whose titles may lead to confusion. *Icones Florae Japonicae* is a university (Imperial Univ., Tokyo) publication, and but one part has appeared, having been issued last April. It is in the editorial charge of Mr. T. Makino. *Phanerogamae et Pteridophytae Japonicae Icon. Illustr.* and *Cryptogamae Japonicae Icon. Illustr.* are the private publications of a few botanists.

THE SOCIETY for Plant Morphology and Physiology met at Johns Hopkins Medical School, Baltimore, Md., Dec. 27 and 28, 1900, under the presidency of D. P. Penhallow. The following officers were elected for the ensuing year: *president*, ERWIN F. SMITH; *vice presidents*, F. C. NEWCOMBE and L. M. UNDERWOOD; *secretary*, W. F. GANONG. The following new members were elected: M. A. CARLETON, F. D. CHESTER, E. B. COPELAND, T. H. KEARNEY, J. W. TOUMEY. The most important business of general interest was the presentation in printed form of the report of the committee on reviews of botanical literature, which has already been referred to in this journal (p. 143). A committee (Messrs. Ganong, Lloyd, and Atkinson) was appointed to take into consideration the subject of a standard college entrance option in botany, to be made as widely acceptable as possible. The address of the retiring president, *A Decade of North American Paleobotany*, has been published in full in *Science*, together with abstracts of the papers presented.